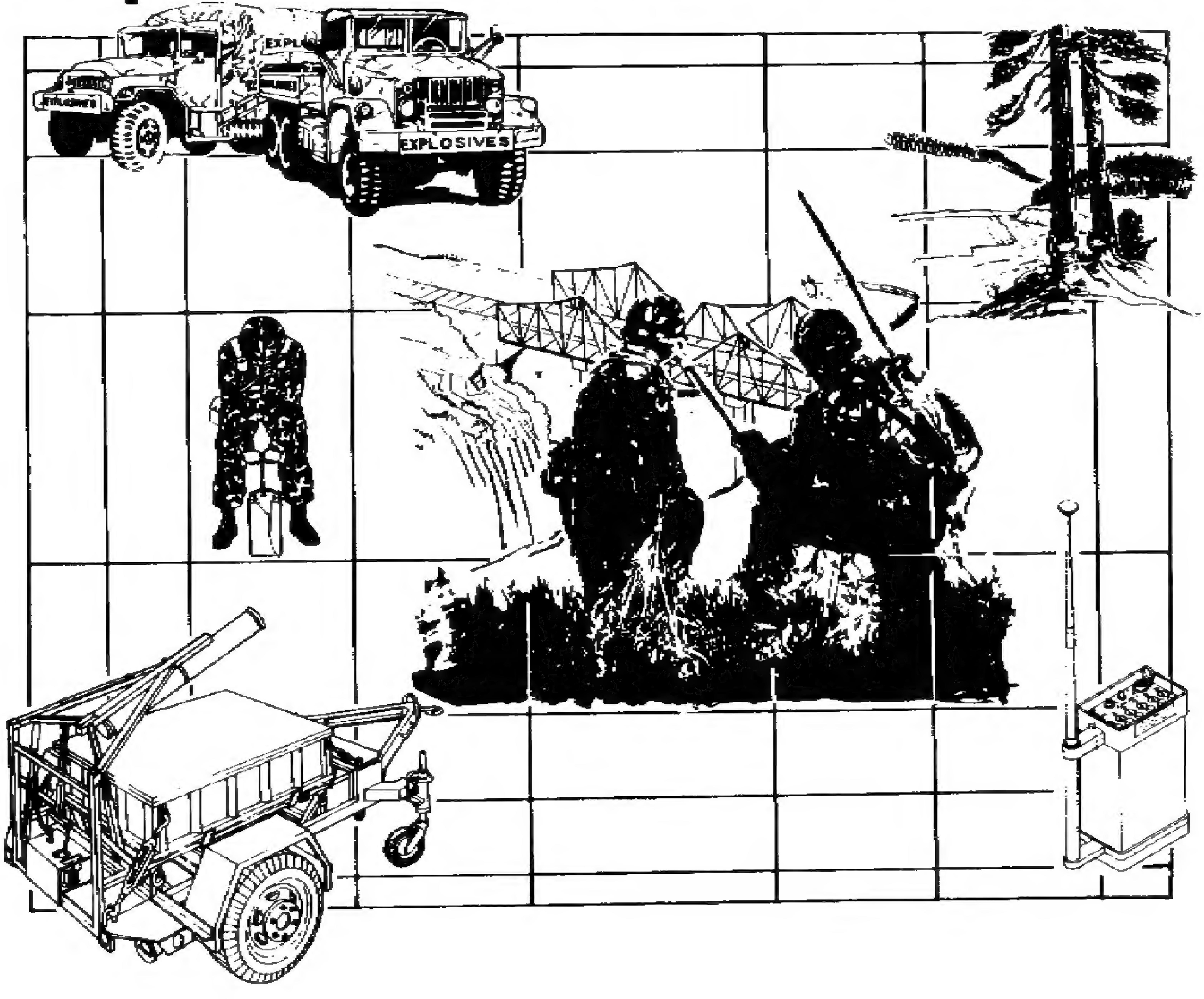
FM 5-25

explosives and demolitions



MARCH 1986

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HEADQUARTERS, DEPARTMENT OF THE ARMY

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 10 March 1986

explosives and demolitions

preface

Explosives and Demolitions is a guide to the types and characteristics of explosives currently used by the United States as well as a reference on modern demolition methods. The manual describes the methods for priming and preparing demolition charges and the ways to use charges to support engineer battlefield requirements.

Demolition missions that use explosive materials accomplish their goals more quickly than those employing other means. Encompassed in a demolition mission are reconnaissance, planning, and coordination as well as selection, calculation, placement, priming, and detonation of charges.

This manual is intended for engineer commanders, noncommissioned officers, and staff officers who perform demolition missions to meet combat engineer requirements in support of maneuver units. It is also intended for commanders, noncommissioned officers, and staff officers who must use demolitions to accomplish a required mission.

The proponent of this publication is the US Army Engineer School. Submit changes for improving this publication on DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forward it directly to Commandant, US Army Engineer School, ATTN: ATZA-TD-P, Fort Belvoir, Virginia 22060-5291.

The provisions of this publication are the subject of International Standardization Agreements (STANAGs): 2017, Orders to the Demolition Guard Commander and Demolition Firing Party Commander (Edition 3); 2036, Land Minefield Laying, Marking, Recording and Reporting Procedures; and 2123, Obstacle Folder (Edition 2) as well as Quadripartite Standardization Agreement (QSTAG) 508, Orders to the Demolition Firing Party Commander.

This manual prescribes DA Form 2203-R, Demolition Reconnaissance Report Form, and it can be found in Appendix E.

Unless otherwise stated, whenever the masculine or feminine gender is used, both men and women are included.

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*This publication supersedes FM 5-25, 5 February 1971.

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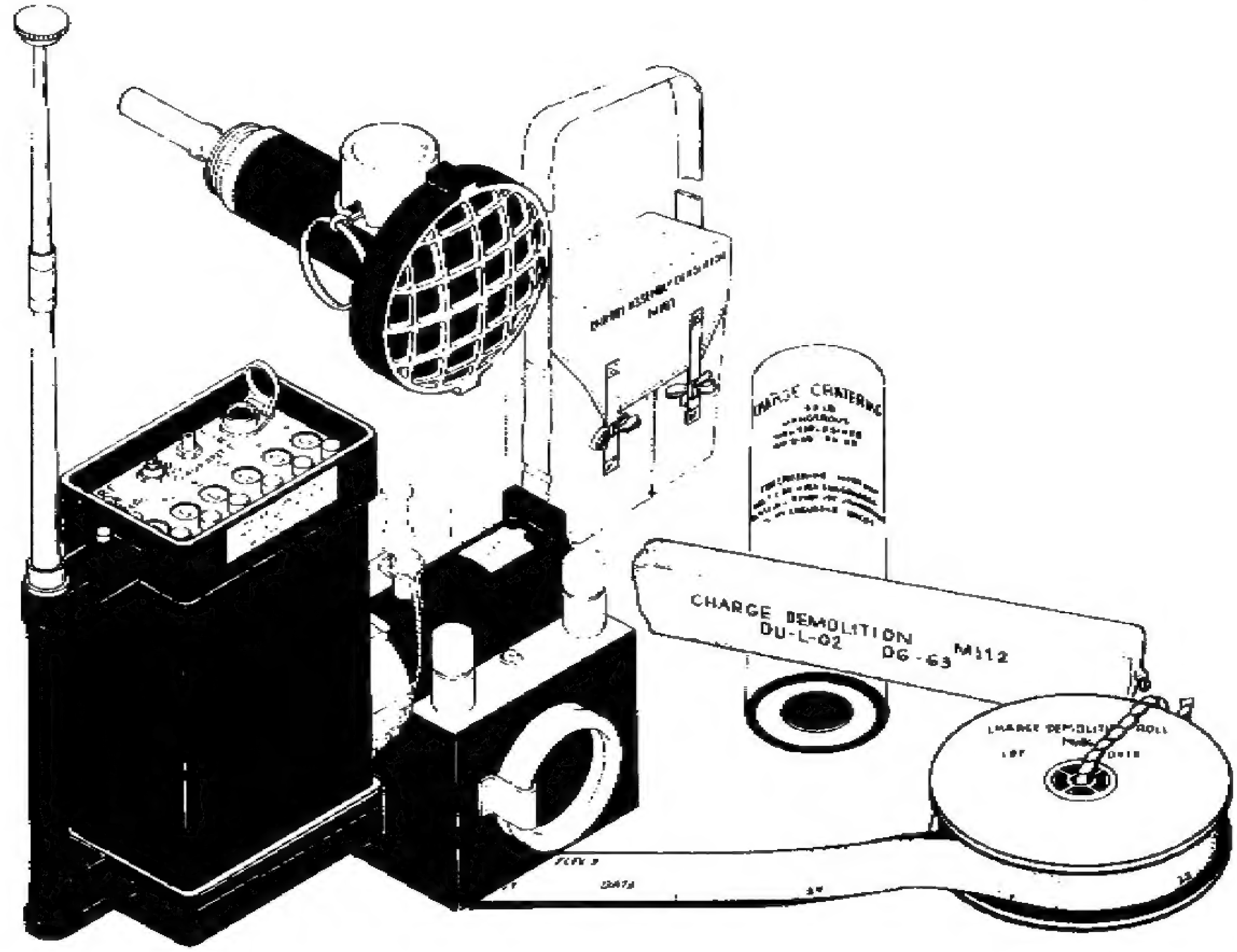


This manual is a guide in the use of explosives to destroy military obstacles and certain construction projects. The contents of this manual are applicable to nuclear and nonnuclear warfare. It includes information on—

- Types, attributes, and uses of explosives and auxiliary equipment.
- Preparation, placement, and firing of charges.
- Charge calculation formulas.
- Deliberate and hasty demolition methods.
- Safety precautions.
- Handling, transportation, and storage of explosives.
- Use of expedient demolition charges.

This chapter deals with the types, characteristics, and uses of explosives and accessories.

MILITARY EXPLOSIVES

Definitions

Military demolition. Military demolition is the destruction by fire, water, explosive, mechanical, or other means of area structures, facilities, or materials to accomplish a military objective. Demolitions are explosives used for such purposes. Demolitions have offensive and defensive uses. Examples are the removal of enemy barriers to facilitate the advance and the construction of friendly barriers to delay or restrict enemy movement.

Explosives. Explosives are substances that, through chemical reaction, violently change to a gaseous form. In doing so, they release pressure and heat equally in all directions. They are classified as low or high according to the detonating velocity or speed (in meters or feet per second) at which this change takes place and other characteristics such as their shattering effect.

Low explosives. Low explosives change from a solid to a gaseous state slowly over a sustained period (up to 400 meters or 1,300 feet per second). This characteristic makes low explosives ideal when a pushing or shoving effect is required. Examples of low explosives are smokeless and black powders.

High explosives. High explosives change to a gaseous state almost instantaneously at 1,000 meters per second (3,280 feet per second) to 8,500 meters per second (27,888 feet per second), producing a shattering effect on the target. Use high explosives when a shattering effect, or *brisance,* is required.

Relative effectiveness (RE) factor. Explosives vary in detonating rate or velocity (meters or feet per second), as well as other characteristics, such as density and energy production. These characteristics determine their effectiveness for cutting, breaching, or cratering charges. Most military demolitions involve cutting or breaching. The amount of explosive used is adjusted by a relative effectiveness (RE) factor, which is based upon the shattering effect of the explosive in relation to that of trinitrotoluene (TNT). The shattering effect of a high explosive is related to its detonating velocity. For example, TNT with a detonating velocity of 6,900 meters per second has a relative effectiveness factor of 1.00, while Composition C4 with a detonating velocity of 8,040 meters per second has a relative effectiveness factor of 1.34 (Table 1-1).

Cratering effect. The cratering effect of high explosives depends upon their total energy content, which determines the amount of energy available to throw the broken material from the crater. Because a shattering effect is not required to form a crater, low-velocity explosives are generally more effective for cratering purposes. Therefore, the relative effectiveness factor is not considered in determining the effect of a cratering charge. Blasting road craters or ditches normally requires large amounts of explosives. Because it is effective and inexpensive, an ammonium nitrate-based cratering charge is used as a standard cratering charge.

Table 1-1. Characteristics of principal US explosives used for demolition purposes

Name	Principal uses	Velocity of detonation (m/sec)	Velocity of detonation (ft/sec)	Relative effectiveness as a breaching charge (TNT = 1.00)	Intensity of poisonous fumes	Water resistance
Black powder	Time blasting fuse	400	1,300	0.55	Dangerous	Poor
Ammonium nitrate	Demolition charge (cratering)	2,700	8,900	0.42	Dangerous	Poor
Amatol 80/20	Bursting charge	4,900	16,000	1.17	Dangerous	Poor
Military dynamite, M1	Demolition charge (quarrying, stumping, and ditching)	6,100	20,000	0.92	Dangerous	Fair
Detonating cord	Priming	6,100 7,300	20,000 24,000		--	Excellent
TNT	Demolition charge (breaching) and composition explosive	6,900	22,600	1.00	Dangerous	Excellent
Tetrytol 75/25	Demolition charge (breaching)	7,000	23,000	1.20	Dangerous	Excellent
Tetryl	Booster charge and composition explosives	7,100	23,300	1.25	Dangerous	Excellent
Sheet explosive M118 and M186	Demolition charge (cutting)	7,300	24,000	1.14	Dangerous	Excellent
Pentolite 50/50	Booster charge and bursting charge	7,450	24,400	-	Dangerous	Excellent
Nitroglycerin	Commercial dynamites	7,700	25,200	1.50	Dangerous	Good
Bangalore torpedo, M1A2	Demolition charge (wire and minefield breaching)	7,800	25,600	1.17	Dangerous	Excellent
Shaped charges M2A3, M2A4, and M3A1	Demolition charge (cutting holes)	7,800	25,600	1.17	Dangerous	Excellent
Composition B	Bursting charge	7,800	25,600	1.35	Dangerous	Excellent
Composition C4 and M112	Demolition charge (cut and breach)	8,040	26,400	1.34	Slight	Excellent
Composition A3	Booster charge and bursting charge	8,100	26,500		Dangerous	Good
PETN	Detonating cord, blasting caps, and demolition charges	8,300	27,200	1.66	Slight	Excellent
RDX	Blasting caps, composition explosives	8,350	27,400	1.60	Dangerous	Excellent

Characteristics

To be suitable for use in military operations, explosives must have certain properties. Military explosives must—

- Be inexpensive to manufacture and capable of being produced from readily available raw material.
- Be relatively insensitive to shock or friction, yet able to positively detonate by easily prepared initiators.
- Have the shattering effect and potential energy adequate for the purpose.
- Be stable enough to retain usefulness for a reasonable time when stored in any climate at temperatures between -80 and +165 degrees Fahrenheit.
- Have high density (weight per unit of volume).
- Be suitable for use under water or in damp climates.
- Have minimum toxicity (poisonous effects) when stored, handled, and detonated.
- Be a convenient size and shape for packaging, storing, distributing, handling, and emplacing by troops.
- Have high energy output per unit of volume.

Detonation

The detonation or burning of all explosives produces poisonous fumes. The chemicals used in explosives are poisonous. Caution personnel against inhaling fumes or ingesting explosives. When explosives are used in closed areas or underground, allow adequate time for the fumes to dissipate before investigation. Control the explosives to prevent their use, such as burning as a source of heat or cooking, for other than their intended purpose.

Fire Hazards

Explosives contain their own oxidizer. Burning explosives cannot be extinguished by smothering or with water. In fact, smothering will probably cause an explosion. Because of the possibility of detonation while explosives are burning, observe the minimum safe distance.

WARNING **Personnel should not attempt to extinguish burning explosive without expert advice and assistance.**

Fire Safety Precautions for Transport

If fire breaks out in a vehicle transporting explosives, try to stop the vehicle away from any populated buildings. Stop traffic in both directions, and warn drivers, passengers, and occupants of nearby buildings to keep at least 2,000 feet away. Inform police and firefighting authorities that the cargo is explosives. If a fire involves only the engine, cab, chassis, or tires, make an effort to put out the fire with fire extinguishers, sand, dirt, or water. If the fire spreads to the body or cargo, STOP FIGHTING THE FIRE AND EVACUATE THE AREA to a distance of at least 2,000 feet.

Selection of Explosives

Explosives usually are selected for a particular purpose based on their relative power. Consider all the characteristics listed in Chapter 1, Characteristics, when choosing the most suitable explosive for a particular demolition project. For detailed information and characteristics of military explosives, see Technical Manual (TM) 9-1300-214. Table 1-1 on page 1-3 contains significant information regarding many of the explosives next described.

Ammonium Nitrate

Ammonium nitrate is the least sensitive of military explosives and must be initiated by a booster charge to successfully detonate. Because of its low sensitivity, ammonium nitrate is widely used in composite explosives where it is combined with a more sensitive explosive (see paragraph on amatol on page 1-6; paragraph on 40-pound ammonium nitrate block demolition charge in Chapter 1, Demolition Charges; and commercial dynamites in Chapter 1, Dynamites.) Ammonium nitrate is not suitable for cutting or breaching charges due to a low detonating velocity. Because of its cratering effect and low cost, ammonium nitrate is used chiefly in cratering and ditching charges. It is widely used commercially in quarrying. Pack ammonium nitrate in an airtight container because it is extremely hygroscopic; that is, it absorbs moisture in the air. Ammonium nitrate or composite explosives containing ammonium nitrate are not suitable for underwater use unless packaged in a waterproof container or detonated immediately after emplacement. Ammonium nitrate prill can also be mixed with No 2 diesel fuel to form a free-flowing, oxygen-balanced explosive mixture called ANFO. It is normally mixed at a ratio of 94 percent ammonium nitrate to 6 percent fuel oil and can be used in place of the standard 40-pound cratering charge. Prime ANFO with a booster charge.

Pentaerythrite Tetranitrate (PETN)

Pentaerythrite tetranitrate (PETN) is highly sensitive and one of the most powerful military explosives. It is comparable in force to cyclonite (RDX) and nitroglycerin. The PETN explosive is used in boosters, detonating cords, and some blasting caps. It is also used in composite explosives with TNT (see the paragraph on pentolite) or with nitrocellulose as a demolition charge such as the M118 demolition charge. The PETN explosive is almost insoluble in water and may be used in underwater demolitions.

Cyclonite (RDX)

Cyclonite (RDX) is highly sensitive and is one of the most powerful military explosives. It is used alone as the base charge in the M6 electric and M7 nonelectric blasting caps. When it is desensitized, it is used as a subbooster, booster, bursting charge, and demolition charge. The principal use of RDX is in composite explosives such as Composition A, B, and C explosives.

Trinitrotoluene (TNT)

Trinitrotoluene (TNT) is the most common military explosive. It is widely used alone or as part of a composite explosive as a booster, bursting, or demolition charge. As a standard explosive, it is used to rate other military high explosives.

Tetryl

Tetryl is used alone as a booster charge and a bursting or demolition charge in some composite explosives. Tetryl is more sensitive and powerful than TNT. However, tetryl and composite explosives containing tetryl are being replaced by RDX and PETN-based explosives which have increased power and shattering effects.

Nitroglycerin

Nitroglycerin is one of the most powerful high explosives. It is comparable in force to RDX and PETN. It is used as the explosive base for commercial dynamites. Nitroglycerin is highly sensitive and is affected by extreme temperatures Due to the sensitivity and the difficulty in handling nitroglycerin, it is not used in military explosives. Do **not** use commercial dynamites in combat areas.

Black Powder

Black powder is the oldest explosive and propellant known. It is a composite made of potassium or sodium nitrate with charcoal and sulfur. Black powder is used in time fuses, some igniters, and some detonators.

Amatol

Amatol is a mixture of ammonium nitrate and TNT. It has been used as a substitute for TNT in bursting charges. The 80-20 amatol (80 percent ammonium nitrate and 20 percent TNT) is used in some older bangalore torpedoes. Because amatol contains ammonium nitrate, it is hygroscopic and must be stored in an airtight container. If properly packaged, amatol can be stored for long periods of time with no change in sensitivity, brisance, or stability.

Composition A3

Composition A3 is a composite explosive containing 91 percent RDX and 9 percent wax, which coats the RDX particles, desensitizes them, and acts as a binder. Composition A3 is used as a booster charge in some newer shaped charges and bangalore torpedoes. It is also used as the main charge in high explosive plastic (HEP) projectiles.

Composition B

Composition B is a composite explosive containing approximately 60 percent RDX, 39 percent TNT, and 1 percent wax. It is more sensitive than TNT. Because of its shattering power and high rate of detonation, Composition B is used as the main charge in shaped charges.

Composition B4

Composition B4 contains 60 percent RDX, 39.5 percent TNT, and 0.5 percent

calcium silicate. It is used as the main charge in newer models of bangalore torpedoes and shaped charges.

Composition C4

Composition C4 is a composite explosive containing 91 percent RDX and 9 percent nonexplosive plasticizers. Composition C4 is also used as a burster charge. It is highly brisant and is moldable over a wide range of temperatures (-70 to +170 degrees Fahrenheit). It is more stable and less subject to erosion by water when used for underwater demolitions.

Tetrytol

Tetrytol is a composite explosive of tetryl and TNT (75 percent tetryl and 25 percent TNT). It is used as a demolition charge. Other mixtures are used as booster charges. Tetrytol is more powerful and brisant than TNT and less sensitive than tetryl.

Pentolite

Pentolite is a mixture of PETN and TNT. Because of its high power and detonating rate, a mixture of 50-50 pentolite (50 percent PETN and TNT) is used as a booster charge in certain models of shaped charges.

Dynamites

Dynamites are of two types—standard and military. Their composition and uses differ.

Standard dynamite. Most dynamites, with the notable exception of military dynamite, contain nitroglycerin plus varying combinations of absorbents, oxidizers, antacids, and freezing point depressants. Dynamites vary greatly in strength and sensitivity depending upon, among other factors, the percentage of nitroglycerin they contain. Use dynamites for general blasting and demolitions, including land clearing, cratering and ditching, and quarrying. For additional information, see Chapter 1, Commercial Dynamites.

Military dynamite. Military dynamite is a composite explosive that contains 75 percent RDX, 15 percent TNT, and 10 percent desensitizers and plasticizers. It is equivalent in strength to 60 percent commercial dynamite. Military dynamite contains no nitroglycerin, and it is more stable and safer to store and handle than commercial dynamite.

Foreign Explosives

Characteristics. Explosives used by foreign countries include TNT, picric acid, amatol, and guncotton. Picric acid is similar to TNT except that it corrodes metals and thus forms extremely sensitive compounds.

WARNING

Do not use a picric acid explosive in a rusted or corroded container. It should not be handled, except to move it very carefully to a safe disposal area for destruction.

Use. Explosives of allied nations and those captured from the enemy may be used to supplement standard supplies. Such explosives, however, should be used only by expert demolitionists and then only according to instructions and directives of theater commanders. Captured bombs, propellants, and other devices may be used with US military explosives for larger demolition projects, such as pier, bridge, tunnel, and airfield destruction (see Appendix B). Most foreign explosive blocks have cap wells large enough to receive US military blasting caps. When used to detonate foreign explosives, these blasting caps should be test fired to determine their adequacy before extensive use since these explosives may be less sensitive than US types.

DEMOLITION CHARGES

Block Demolition Charges

Block demolition charges are prepackaged high explosive charges used in general demolition operations such as cutting, breaching, and cratering. They are composed of the high explosive TNT, tetrytol, Composition C series, and ammonium nitrate. They are made in the form of rectangular blocks excepting the 40-pound ammonium nitrate block demolition charge, military dynamite, and the ¼-pound TNT block demolition charge, which are made in cylindrical form. The various block charges available are described in the text that follows as well as Table 1-2. For detailed information and characteristics of demolition charges and accessories, see TM 43-0001-38.

Table 1-2. Characteristics of block demolition charges

Nomenclature	Explosive	Weight	Size, in	Velocity of detonation, m/sec and ft/sec	Relative effectiveness (RE) factor	Packaging and total weight
Charge, Demolition: Block (TNT)	TNT	¼ lb ½ lb 1 lb	1½ D x 3½ L 1¾ x 1¾ x 3¾ 1¾ x 1¾ x 7	6,900 m/sec, 22,600 ft/sec	1.00	200 per wooden box, wt: 79 lb 96 per wooden box, wt: 65 lb 48, 50, or 56 per wooden box, wt: 80 lb
Charge, Demolition: M112 block	Comp C4	1¼ lb	1 x 2 x 11	8,040 m/sec, 26,400 ft/sec	1.34	1 per plastic bag, 30 bags (30 chg) per wooden box, wt: 48 lb
Charge, Demolition: M118 block	PETN or RDX based	Block: 2 lb Sheet: ½ lb	Block: 1¼ x 3¼ x 12½ Sheet ¼ x 3 x 12	7,190 m/sec, 23,600 ft/sec	1.14	1 block (4 sheets) per plastic wrapper, 20 blocks per wooden box, wt: 52 lb
Charge, Demolition: M186 roll	PETN or RDX based	25 lb (½ lb/ft)	¼ in x 3 in x 50 ft	7,190 m/sec, 23,600 ft/sec	1.14	1 roll per canvas bag, 3 bags per wooden box, wt: 115 lb
Charge, Demolition: Ammonium nitrate	Ammonium nitrate with TNT booster	43 lb	7 D x 24 L	3,400 m/sec, 11,000 ft/sec	0.42	1 metal container per wooden box, wt: 52 lb

TNT Block Demolition Charge

Characteristics. TNT demolition blocks, shown in Figure 1-1, are issued in three sizes as listed in Table 1-2. The ¼-pound block is issued in a cylindrical waterproof olive-drab cardboard container. The ½ pound and 1 pound blocks are issued in similar rectangular containers. All of the three charges have metal ends with a threaded cap well in one end. Additional characteristics are listed in Table 1-1 on page 1-3.

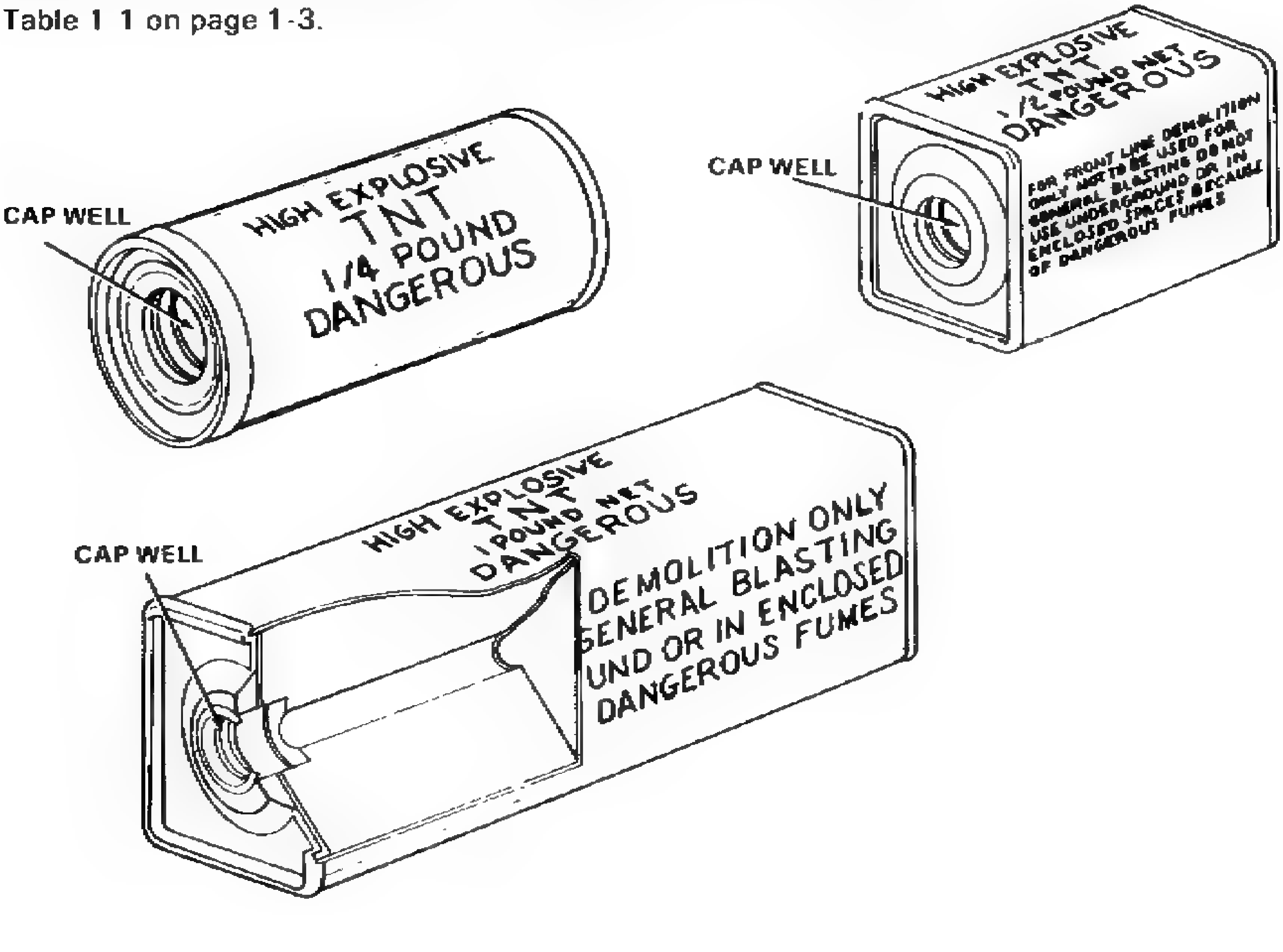


Figure 1-1. TNT block demolition charges

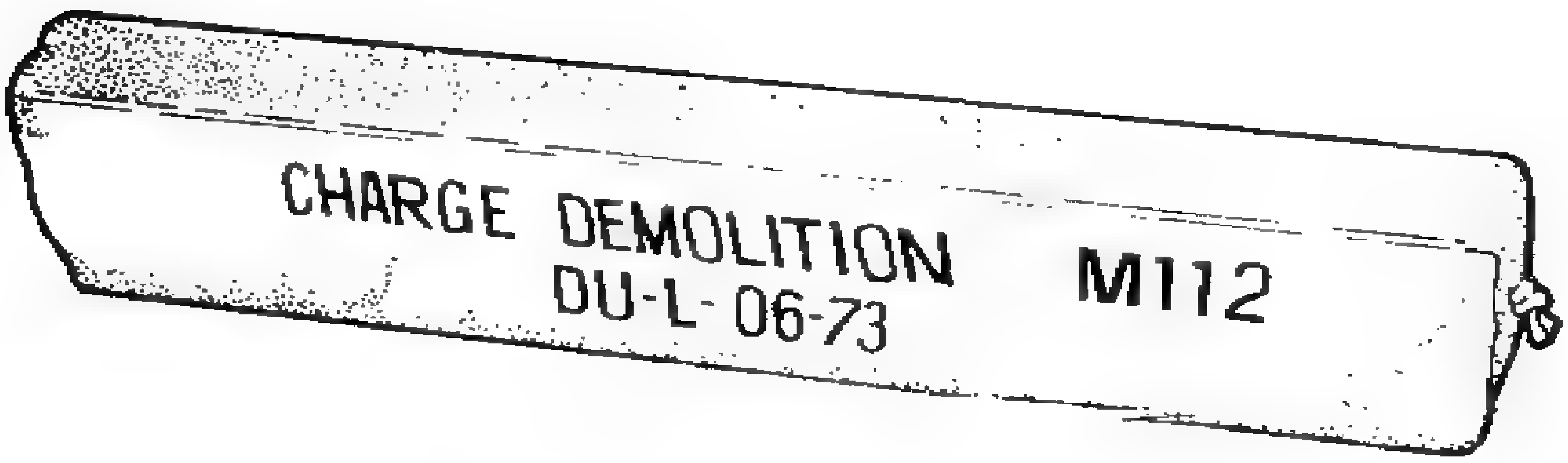
Use. Trinitrotoluene block demolition charges are standard demolition charges used for all types of demolition work. However, the ¼-pound charge is used primarily for training purposes.

Advantages. Trinitrotoluene demolition charges have a high detonating velocity. They are stable, relatively insensitive to shock or friction, and water resistant. They are also convenient in size, shape, and packaging.

Limitations. Trinitrotoluene block demolition charges cannot be molded and are difficult to use on an irregular-shaped target. Trinitrotoluene is **not** recommended for use in closed spaces because its explosion produces poisonous gases.

M112 Block Demolition Charge

Characteristics. The M112 block demolition charge consists of 1¼ pounds of Composition C4 packed in a Mylar-film container with a pressure-sensitive adhesive tape on one surface (Figure 1-2). The tape is protected by a peelable paper cover. Additional characteristics of the M112 block are listed in Table 1-2 on page 1-8.



NOTE: The Composition C4 in some M112 blocks is dull gray and packed in a clear Mylar-film container. In blocks of recent manufacture, Composition C4 is white and packed in an olive-drab, Mylar-film container.

Figure 1-2. M112 block demolition charge

Use. The M112 block demolition charge is used primarily for cutting and breaching all types of demolition work. Because of its moldability and high brisance, the charge is ideally suited for cutting irregularly shaped targets such as steel. The adhesive backing allows the charge to be attached to any relatively flat, clean, dry surface above freezing point.

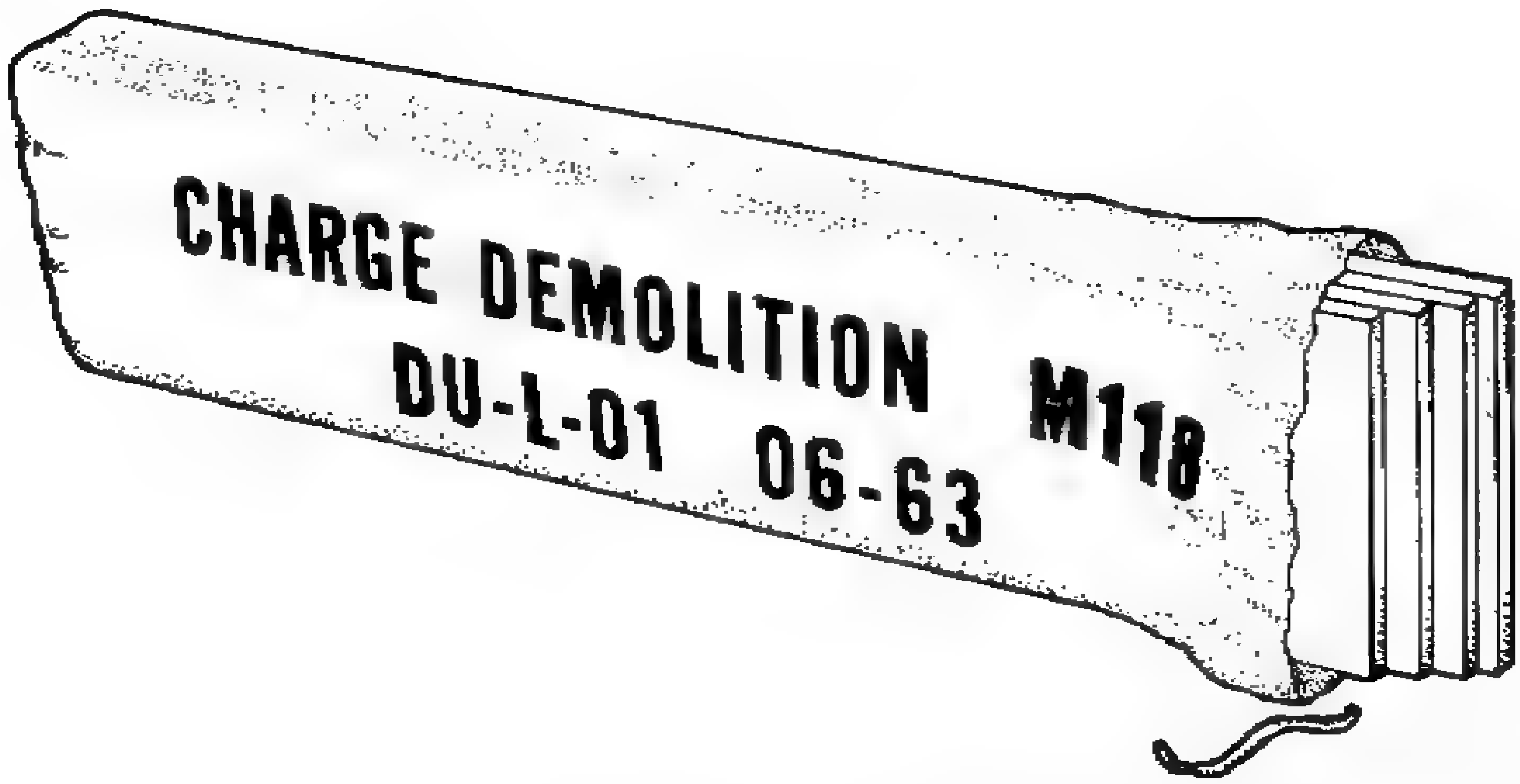
Advantages. The M112 block demolition charge can be cut and molded to fit irregularly shaped targets while being easily attached to the target. The color of the wrapper aids in camouflage.

Limitations. Odd weight makes calculating charge weights difficult. Adhesive tape will not adhere to wet, dirty, rusty, or frozen surfaces.

WARNING | **Composition C4 explosives are poisonous and dangerous if chewed or ingested; their detonation or burning produces poisonous fumes.**

M118 Block Demolition Charge

Characteristics. The M118 block demolition charge, or *sheet explosive,* is a block of four ½-pound sheets of flexible explosive packed in a plastic envelope (Figure 1-3). Twenty M118 charges and a package of 80 M8 blasting cap holders are packed in a wooden box. Each sheet of the explosive has a pressure-sensitive adhesive tape attached to one surface. Additional characteristics are listed in Table 1-2 on page 1-8.



NOTE: The exact type of explosive contained in M118 demolition charges will vary with the manufacturer. Some manufacturers currently use PETN as a basic explosive; others use RDX. Charges in the future may include other explosives

Figure 1-3. M118 block demolition charge

Use. The M118 demolition charges are designed as a cutting charge especially against steel targets. The sheets of explosive can be quickly applied to irregular and curved surfaces and easily cut to any desired dimensions. The M118 demolition charge may be used for small breaching charges but should not be used as a bulk explosive charge because of its high cost.

Advantages. The flexibility and adhesive backing of the sheets allow them to be applied to a large variety of targets. The ½ pound sheets can be cut to the desired dimensions and applied in layers to achieve the desired thickness. They are not affected by water and may be used in underwater demolitions.

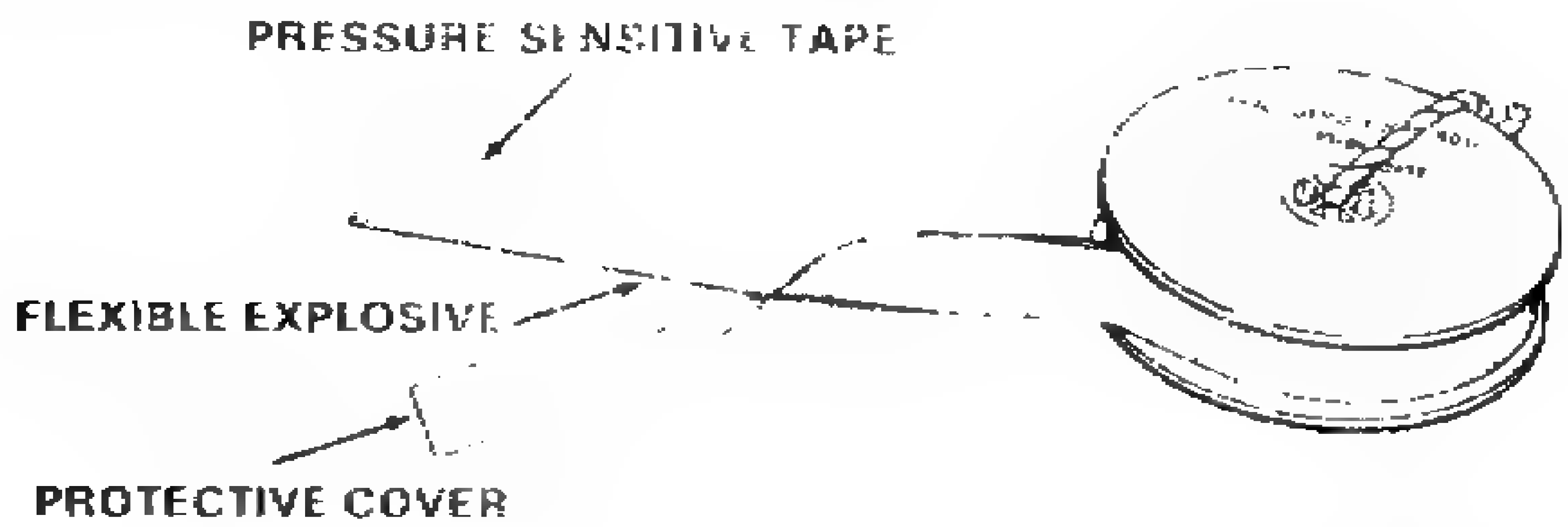
Limitations. Adhesive tape will not adhere to wet, dirty, rusty, or frozen surfaces.

WARNING | **Cut sheet explosives with a sharp steel knife on a nonsparking surface. Do not use shears.**

M186 Roll Demolition Charge

Characteristics. The M186 roll demolition charge, shown in Figure 1-4 (page 1-12), is identical to the M118 demolition charge except that the sheet explosive is in the form of a 50-foot roll on a plastic spool, rather than in sheet form. Each

foot of the roll provides approximately ½ pound of explosive. Included with each roll are 15 M8 blasting cap holders and a canvas bag with a carrying strap. Additional characteristics are given in Table 1-2 on page 1-8



NOTE. The exact type of explosive contained in M186 demolition charges will vary with the manufacturer. Some manufacturers currently use PETN as a basic explosive. Others use RDX. Charges in the future may include other explosives

Figure 1-4. M186 roll demolition charge

Use. The M186 roll demolition charge is used in the same manner as the M118 block demolition charge. The M186 charge is adaptable for demolishing targets that require the use of flexible explosives in lengths longer than 12 inches.

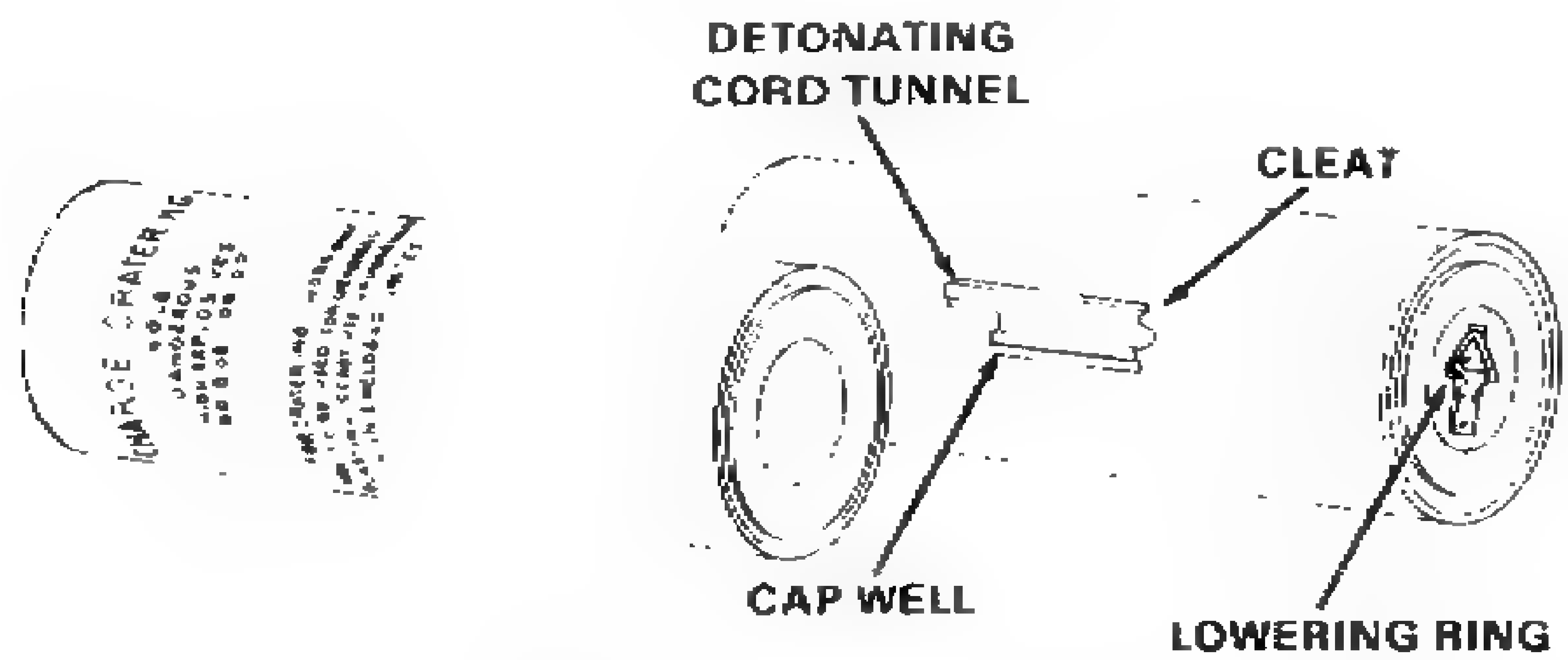
Advantages The M186 roll demolition charge has all the advantages of the M118 charge. The M186 charge may be cut to the exact lengths desired.

Limitations. The adhesive backing will not adhere to wet, dirty, rusty, or frozen surfaces.

WARNING | **Cut sheet explosives with a sharp steel knife on a nonsparking surface. Do not use shears.**

Forty-pound Ammonium Nitrate Block Demolition Charge

Characteristics. Figure 1-5 shows the 40-pound ammonium nitrate block demolition charge or cratering charge. It is a watertight cylindrical metal container with approximately 30 pounds of an ammonium nitrate-based explosive and a TNT based explosive booster of approximately 10 pounds in the center portion next to the priming tunnels. The two priming tunnels are attached to the outside of the container midway between the ends. One tunnel serves as a cap well for priming the block demolition charge with an M6 electric or M7 nonelectric military blasting cap. The other tunnel is used for priming, with the detonating cord passing through the tunnel and knotted at the end. A cleat between the tunnels is provided for securing the time blasting fuse, electrical firing wire, or detonating cord in place. A metal ring is provided on the top of the container for lowering the charge into the hole. Additional characteristics are listed in Table 1-2 on page 1-8



NOTE: Dual prime ammonium nitrate cratering charges.

Figure 1-5. A 40-pound ammonium nitrate block demolition charge (cratering charge)

Use. The 40-pound ammonium nitrate block demolition charge is suitable for cratering and ditching operations. It has been designed as a standard cratering charge but can also be used in destroying buildings, fortifications, and bridge abutments.

Advantages. The size and shape of the charge make it ideal for cratering operations. It is inexpensive to produce compared to other explosives.

Limitations. Ammonium nitrate absorbs moisture. When wet, it is impossible to detonate. To ensure detonation, use only those metal containers showing no evidence of water damage. Detonate all the charges placed in wet or damp boreholes as soon as possible.

DYNAMITES

M1 Military Dynamite

Characteristics. The M1 military dynamite is an RDX-based composite explosive containing no nitroglycerin (Figure 1-6). The M1 military dynamite is packaged in ½-pound, paraffin-coated, cylindrical paper cartridges which have a nominal

Figure 1-6. M1 military dynamite

diameter of 1¼ inches and nominal length of 8 inches. Additional characteristics are given in Table 1-3.

Use. The M1 military dynamite is used in military construction, quarrying, ditching, and service demolition work. It is suitable for underwater demolitions.

Advantages. Military dynamite will not freeze in cold storage nor exude in hot storage. The composition does not absorb or retain moisture. Shipping containers do not require turning during storage. It is safer to store, handle, and transport than 60-percent commercial dynamite. Military dynamite may be used in combat areas.

Limitations. Military dynamite is reliable underwater only up to 24 hours. Because of its low sensitivity, sticks of military dynamite must be well compacted to ensure complete detonation of the entire charge. The M1 dynamite is not efficient as a cutting or breaching charge.

WARNING

There must not be any voids in the loading of boreholes in quarrying. Military dynamite will eventually detonate if set afire in a confined space. Thus, a secondary explosion can result from a borehole with a void in its loading. After the first blast, it may take up to 15 minutes for such an explosion to occur.

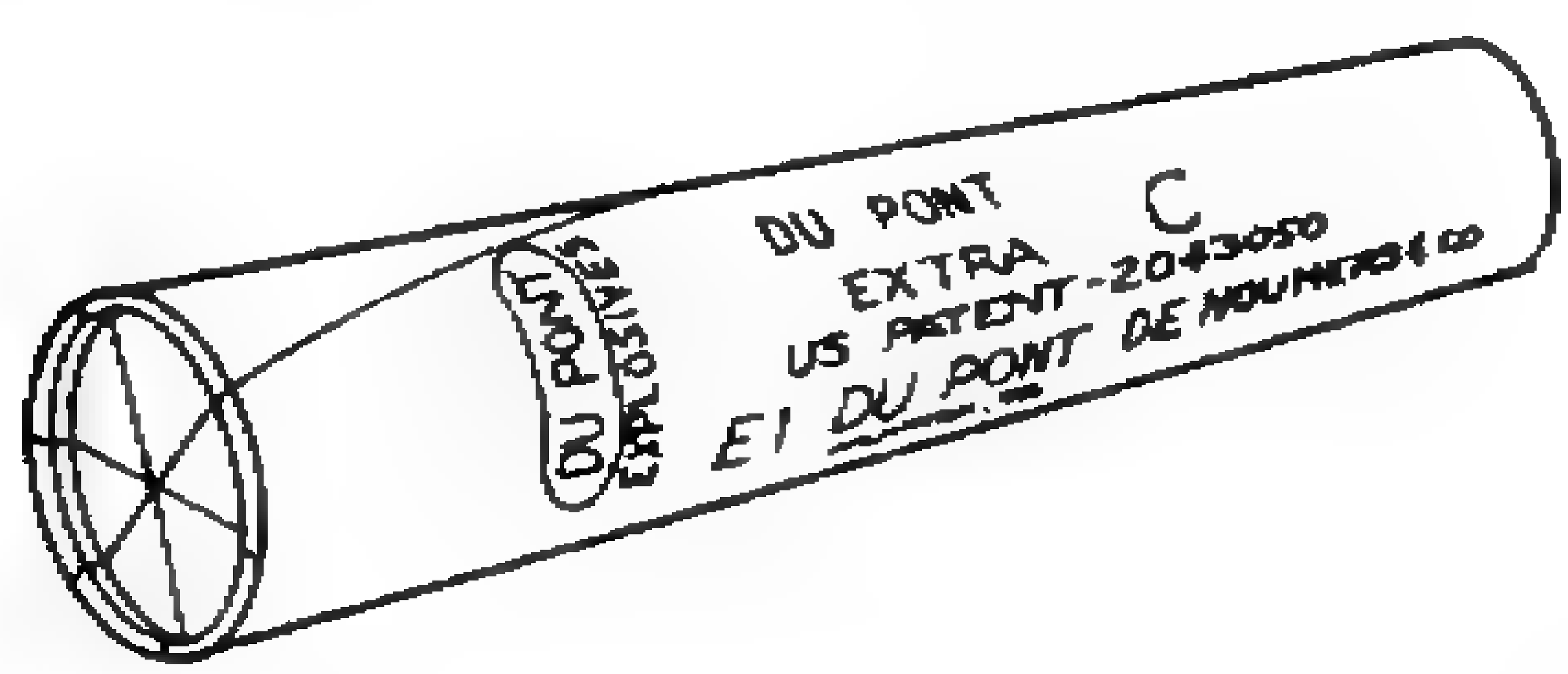
Table 1-3. Characteristics of dynamites

Name		Principal uses	Velocity of detonation, m/sec and ft/sec	Relative effectiveness as a breaching charge	Intensity of poisonous fumes	Water resistance
Military dynamite, M1		Demolition charge	6,100 m/sec, 20,000 ft/sec	0.92	Dangerous	Good
Straight dynamite (commercial)	40%	Demolition charges	4,600 m/sec, 15,000 ft/sec	0.65	Dangerous	Good (if fired within 24 hours)
	50%		5,500 m/sec, 18,000 ft/sec	0.79		
	60%		5,800 m/sec, 19,000 ft/sec	0.83		
Ammonia dynamite (commercial)	40%		2,700 m/sec, 8,900 ft/sec	0.41	Dangerous	Poor
	50%		3,400 m/sec, 11,000 ft/sec	0.46		
	60%		3,700 m/sec, 12,000 ft/sec	0.53		
Gelatin dynamite (commercial)	40%		2,400 m/sec, 7,900 ft/sec	0.42	Slight	Good
	50%		2,700 m/sec, 8,900 ft/sec	0.47		
	60%		4,900 m/sec, 16,000 ft/sec	0.76		
Ammonia-gelatin dynamite (commercial)	40%		4,900 m/sec, 16,000 ft/sec	---	Slight	Excellent
	60%		5,700 m/sec, 18,700 ft/sec	---		

Commercial Dynamites

Characteristics. Commercial dynamite is sensitive to shock and friction (Figure 1-7). Therefore, it is not generally used in combat areas. Commercial types of dynamite are straight, ammonia, gelatin, and ammonia-gelatin. Descriptions and traits follow. (Additional characteristics are given in Table 1-3.)

- Straight dynamite consists of nitroglycerin and a nonexplosive filler. The percentage corresponds to the relative amount of nitroglycerin contained in each stick.
- Ammonia dynamite is composed of ammonium nitrate and nitroglycerin. The percentage composition is computed in the same way as for straight dynamite.
- Gelatin dynamite is a plastic dynamite with an explosive base of nitrocotton dissolved in nitroglycerin. It is relatively insoluble in water.
- Ammonia gelatin dynamite is a plastic dynamite with an explosive base of nitrocotton dissolved in nitroglycerin with ammonium nitrate added. It is suitable for underwater use.



NOTE: Do not use commercial dynamite in combat areas unless required

Figure 1-7. Commercial dynamite

Detonation. Commercial dynamites can be exploded when primed with a commercial No 6 or larger blasting cap, a military electric or nonelectric blasting cap, or detonating cord.

Storage. When straight dynamite is stored, the nitroglycerin tends to settle to the bottom of the sticks. To prevent this settling, straight dynamite cases should be turned at frequent or regular intervals (see TM 9-1300-206).

Old dynamite. Old dynamite can be recognized by the oily substance collected on the casing or stains appearing on the wooden packing of the nitroglycerin from the porous base.

WARNING **Dynamite in this state is extremely sensitive and must not be used. It should be destroyed in accordance with TM 9-1300-206 or the manufacturer's recommendations.**

Low-temperature effects. The sensitivity of commercial dynamite decreases at lower temperatures until the dynamite freezes.

WARNING | **Because of the crystallization that occurs as nitroglycerin freezes, dynamite becomes extremely sensitive and should not be used. Frozen dynamite can be recognized by its hardness and the appearance of crystals.**

SPECIAL DEMOLITION CHARGES AND ASSEMBLIES

Shaped Demolition Charges

Shaped demolition charges used in military operations are cylindrical blocks of high explosive, having a conical cavity in one end which directs the cone liner material into a narrow jet for penetrating materials (Figure 1-8). It is not effective underwater since water in the conical cavity will prevent the high-velocity jet from forming. To obtain maximum effectiveness, locate the cavity at the specified standoff distance from the target, and detonate the charge from the exact rear center of the charge. Conventional methods of dual priming are not applicable to shaped charges.

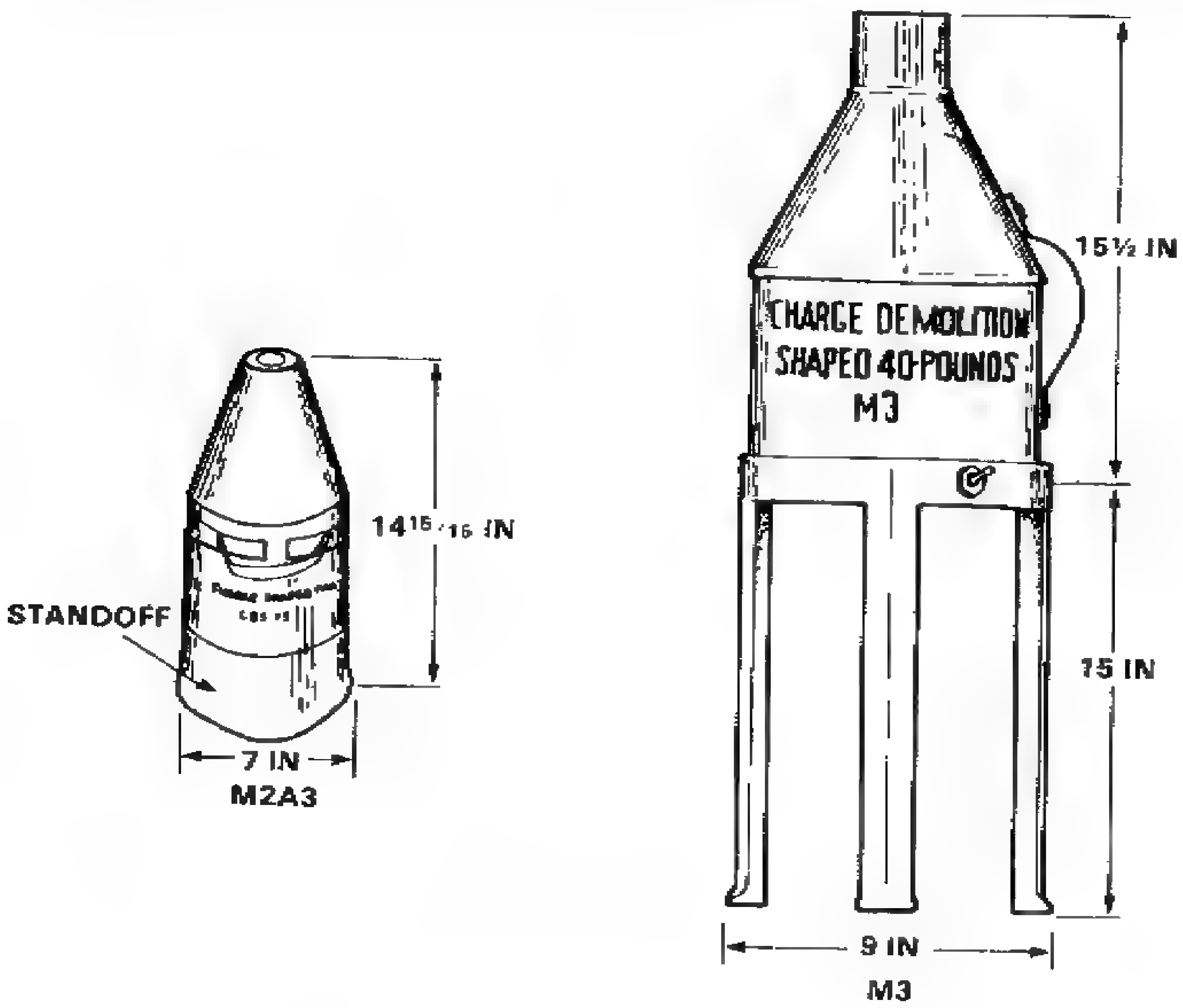


Figure 1-8. Typical shaped charges

Fifteen-pound M2A3 shaped demolition charge. The M2A3 charge contains approximately 9½ pounds of Composition B with a 50-50 pentolite booster weighing approximately 2 pounds. It is packed in a moisture-resisting molded fiber container. Older models are completely pentolite loaded. A cylindrical fiber base slips onto the end of the charge to provide a standoff distance. A cone of glass is used as a cavity liner. Additional characteristics are listed in Table 1-4.

Fifteen-pound M2A4 shaped demolition charge. The M2A4 charge is the same as the M2A3 charge in performance, but is less sensitive to gunfire. It differs in the booster size and materials as follows: the 50-50 pentolite booster has been replaced by 50 grams of Composition A3, and the main charge of Composition B has been increased to maintain the same total weight as the M2A3 charge. Additional characteristics are listed in Table 1-4.

Forty-pound M3 shaped demolition charge. The M3 shaped charge contains approximately 27½ pounds of Composition B with a 50-50 pentolite booster in a metal container. The cavity liner is made of metal. To obtain a standoff distance, a metal tripod is provided Additional characteristics of this charge are listed in Table 1-4.

Forty-pound M3A1 shaped demolition charge. The M3A1 charge is the same as the M3 charge in performance, but is less sensitive to gunfire. It differs in the booster size and material as follows: the 50-50 pentolite booster has been replaced by a booster of approximately 50 grams of Composition A3, and the main charge of Composition B has been increased to maintain the same total weight as the M3 charge.

Table 1-4. Characteristics of shaped demolition charges

Type	Explosive	Weight	Size, in	Packaging and total weight
Charge, Demolition: Shaped 15-lb, M2A3	Pentolite or composition B, with 50/50 pentolite booster	15 lb	14 15/16 x 7 in w/ fiberboard standoff	1. 2 per wooden box. wt: 58 lb 2. 3 per wooden box. wt: 65 lb
Charge, Demolition, Shaped 15 lb, M2A4	Composition B, with composition A3 booster	15 lb	14 15/16 x 7 in w/ fiberboard standoff	3 per wooden box. wt: 65 lb
Charge, Demolition, Shaped 40 lb, M3	Composition B, with 50/50 pentolite booster	40 lb	15½ x 9 in less standoff	1 charge per wooden box. wt. 65 lb
Charge, Demolition: Shaped 40-lb, M3A1	Composition B, with composition A3 booster	40 lb	15½ x 9 in less standoff	1 charge per wooden box wt: 65 lb

Use. Shaped demolition charges are used primarily to bore holes in earth, metal, masonry, concrete, and paved and unpaved roads. Their effectiveness depends largely on their shape, the material of which they are made, the explosive, and proper placement. The penetrating capabilities in various materials and proper standoff distances are discussed in Chapter 3.

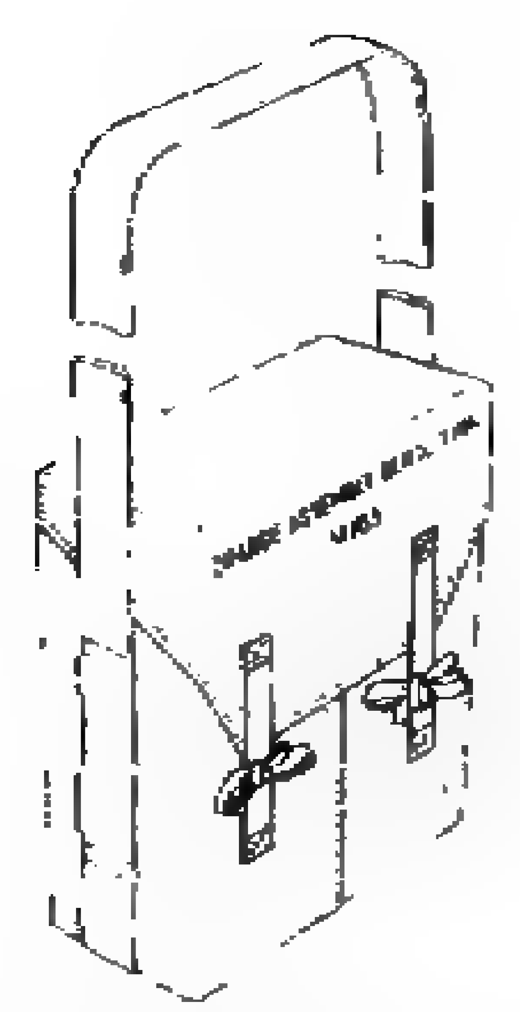
Special precautions. To achieve the maximum effectiveness of shaped charges—

- Center the charge over the target point.
- Set the axis of the charge in line with the direction of the desired hole.
- Use the pedestal provided to obtain the proper standoff distance.
- Remove any obstruction in the cavity liner or between the charge and the target.

M183 Demolition Charge Assembly

Characteristics. The M183 demolition charge assembly or *satchel charge* consists of 16 M112 (Composition C4) demolition blocks and 4 priming assemblies for a total explosive weight of 20 pounds. The demolition blocks are packed in two bags, eight blocks per bag, and placed in an M85 canvas carrying case. One assembly is packed in a canvas carrying bag, and two bags are packed in a wooden box 17⅛ by 11½ by 12½ inches. The gross package weight is 57 pounds. Each priming assembly consists of a 5-foot length of detonating cord with an RDX booster crimped to each end and a pair of M1 detonating cord clips for attaching the priming assembly to the detonating cord main line.

Use. The M183 demolition charge assembly, shown in Figure 1-9, is used primarily in breaching obstacles or demolition of structures where large demolition charges are required. It is also effective against obstacles such as small dragon's teeth approximately 3 feet high and 3 feet wide at the base. The M183 demolition charge assembly replaces the M37 demolition charge assembly as the standard item of issue.



CARRYING CASE M85
(FILLED)

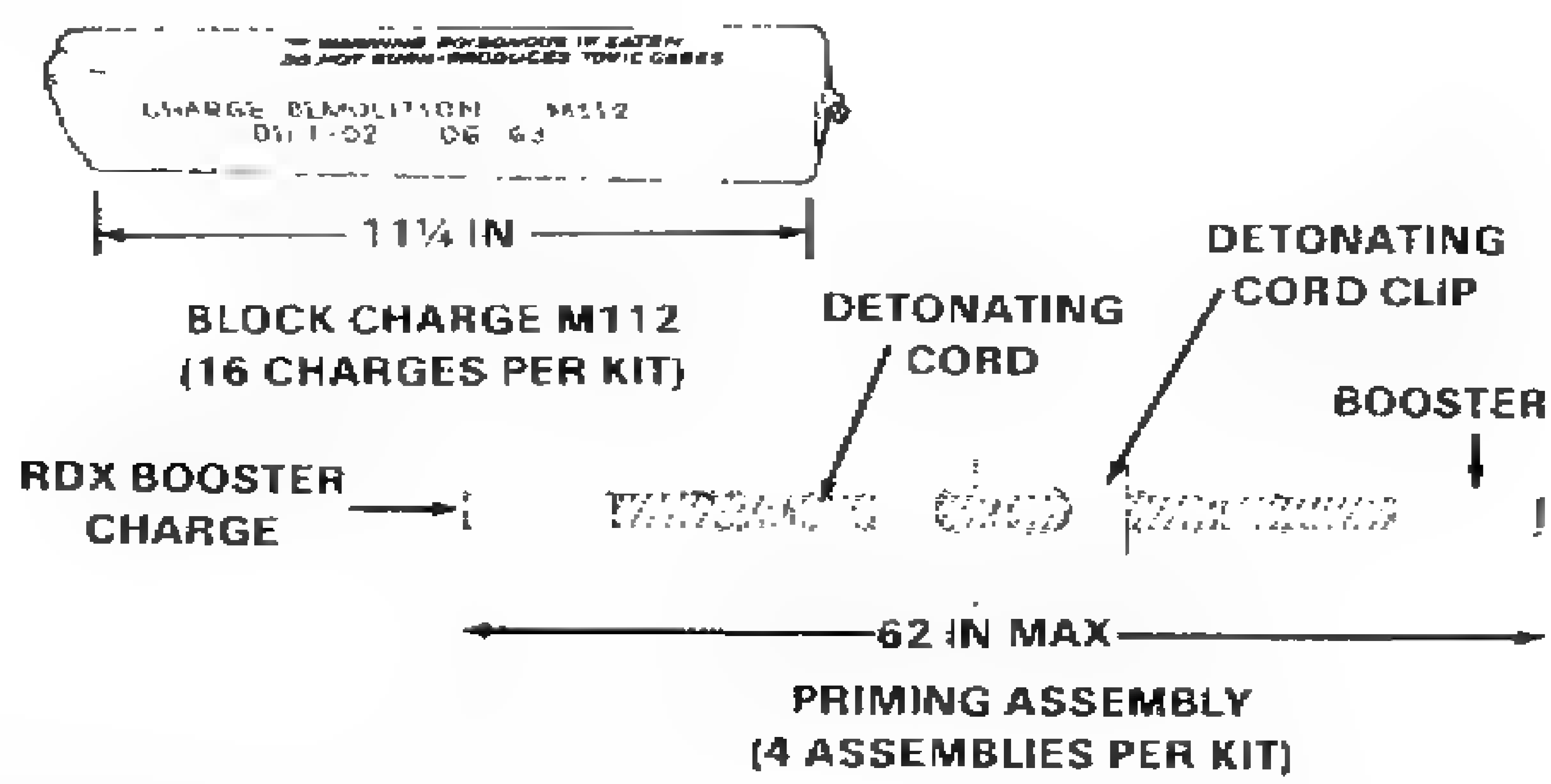


Figure 1-9. M183 demolition charge assembly

Detonation. Detonate the M183 demolition charge assembly by means of a priming assembly and an electric or nonelectric blasting cap, or by the detonating cord ring main attached by means of the detonating cord clips provided.

M1A1 and M1A2 Bangalore Torpedo Demolition Kits

Characteristics. Each kit consists of 10 loading assemblies. The loading assemblies, or torpedoes, are steel tubes 5 feet long and 2⅛ inches in diameter, grooved, and capped at each end (Figure 1-10). The torpedoes in the M1A1 kit are loaded with amatol and a 4-inch booster of TNT at each end. The torpedoes in the M1A2 kit are identical to those in the M1A1 kit except the main explosive charge is Composition B and the 4-inch booster at each end is Composition A3. Connecting sleeves and nose sleeves are provided in each kit. Additional characteristics are listed in Table 1-5.

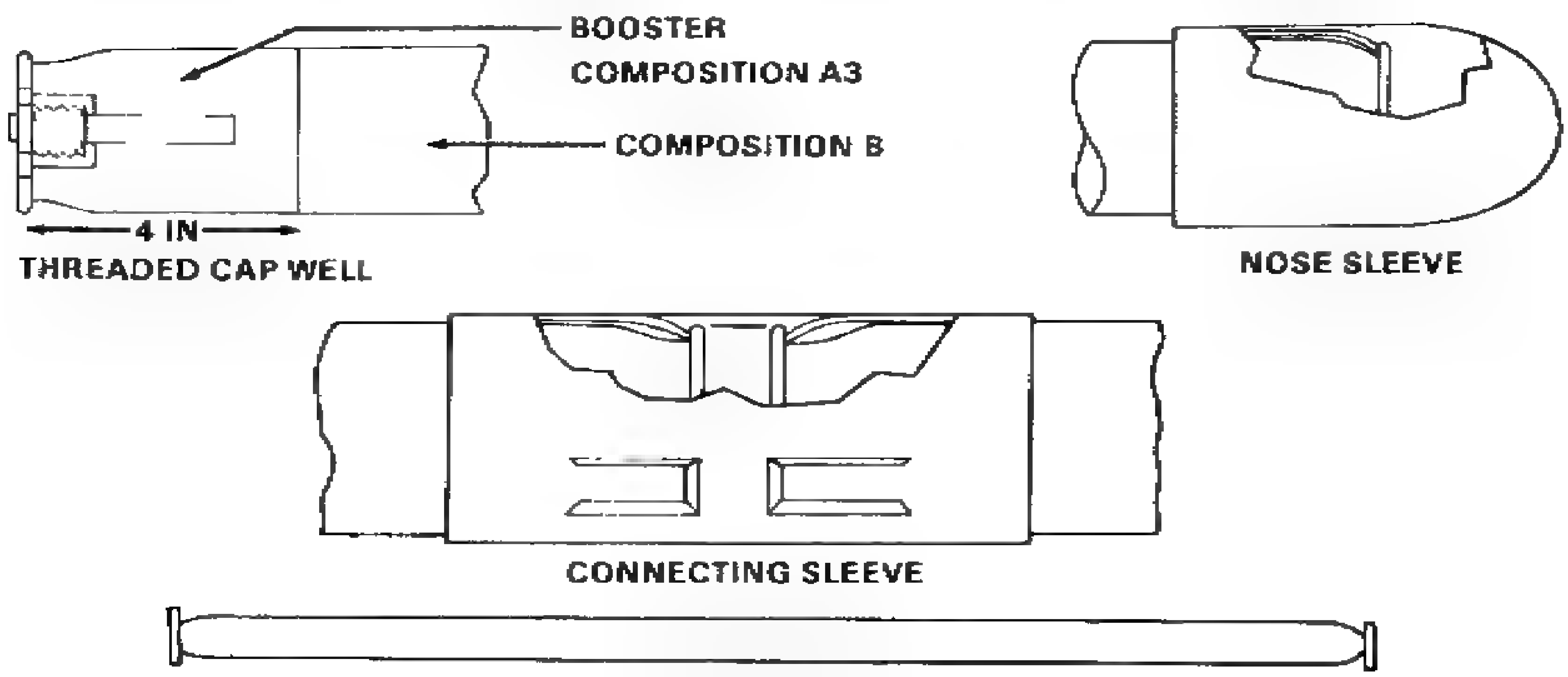


Figure 1-10. M1A2 bangalore torpedo

Table 1-5. Characteristics of bangalore torpedoes

Type	Components	Torpedo weight	Explosive per torpedo	Packaging and total weight
M1A1	10 loading assemblies or torpedoes, 10 connecting sleeves, one nose sleeve	Approx 13 lb	Approx 9 lb amatol and TNT booster	One kit packed in wooden box, 64⅛ x 13⅛ x 7⅛ in. wt: 176 lb
M1A2	10 loading assemblies or torpedoes, 10 connecting sleeves, one nose sleeve	Approx 15 lb	Approx 10.5 comp B4 and 1 lb comp A3 booster	One kit packed in wooden box, 60⅝ x 13¾ x 4 9/16 in. wt: 198 lb

Use. The bangalore torpedo demolition kit is used to clear paths through barbed-wire entanglements, minefields, heavy undergrowth, and bamboo. It clears a path approximately 3 to 4 meters wide through barbed-wire entanglements. In minefield breaching, it will explode all antipersonnel mines and most of the antitank mines in a narrow footpath, approximately 1 meter wide. Many of the mines at the sides, however, may be shocked into a sensitive state. Thus extreme care is necessary in any further mine clearing.

Assembly. All sections have a threaded cap well at each end. To assemble two or more tubes, press a nose sleeve onto one end of one tube, and then connect successive tubes using the connecting sleeves provided until the desired length is reached. The connecting sleeves provided make rigid joints. The nose sleeve assists the user in pushing the torpedo through entanglements and across the ground. It is advisable to attach an improvised part, similar to a loading section without an explosive on the end, to prevent premature detonation by a mine as the torpedo is shoved into place.

Detonation. Military electric or nonelectric blasting caps are used to detonate the bangalore torpedo. In obstacle clearance, protect the cap well at the end with tape or a wooden plug while the torpedo is being pushed into place. Prime the bangalore torpedo after it has been placed with either a military electric or nonelectric blasting cap and time fuse, detonating cord, or by use of an 8- or 15-second delay detonator.

Projected Charge Demolition Kits

Characteristics. Projected charge demolition kits consist of semirigid or flexible linear demolition charges, components to transport the charge, components to project or pull the charge into position, and components to detonate it. This kind of charge is designed to clear a pathway through antipersonnel or antitank minefields. Some kits can also be used against other types of obstacles.

M1E1 projected charge demolition kit (antipersonnel mine-clearing). This demolition kit is designed to clear a pathway through antipersonnel minefields (Figure 1-11). The M1E1 has the M60 weatherproof time blasting fuse igniter and the 15-second delay M1A2 percussion detonator.

The kit consists of a nylon-covered detonating cable, propulsion unit, launcher, fuse igniter, delay detonator, anchor stake, and carrying case. The explosive item, or detonating cable, is 1 inch in diameter and approximately 170 feet (52 meters) long; it weighs 63 pounds, 46 pounds of which is oil-soaked PETN. The detonating cable is composed of 19 strands of special detonating cord, each containing 100 grains of PETN per foot. This differs from the regular (reinforced) detonating cord, which contains only 50 to 60 grains of PETN per foot. Regular detonating cord cannot be used as a substitute in the kit.

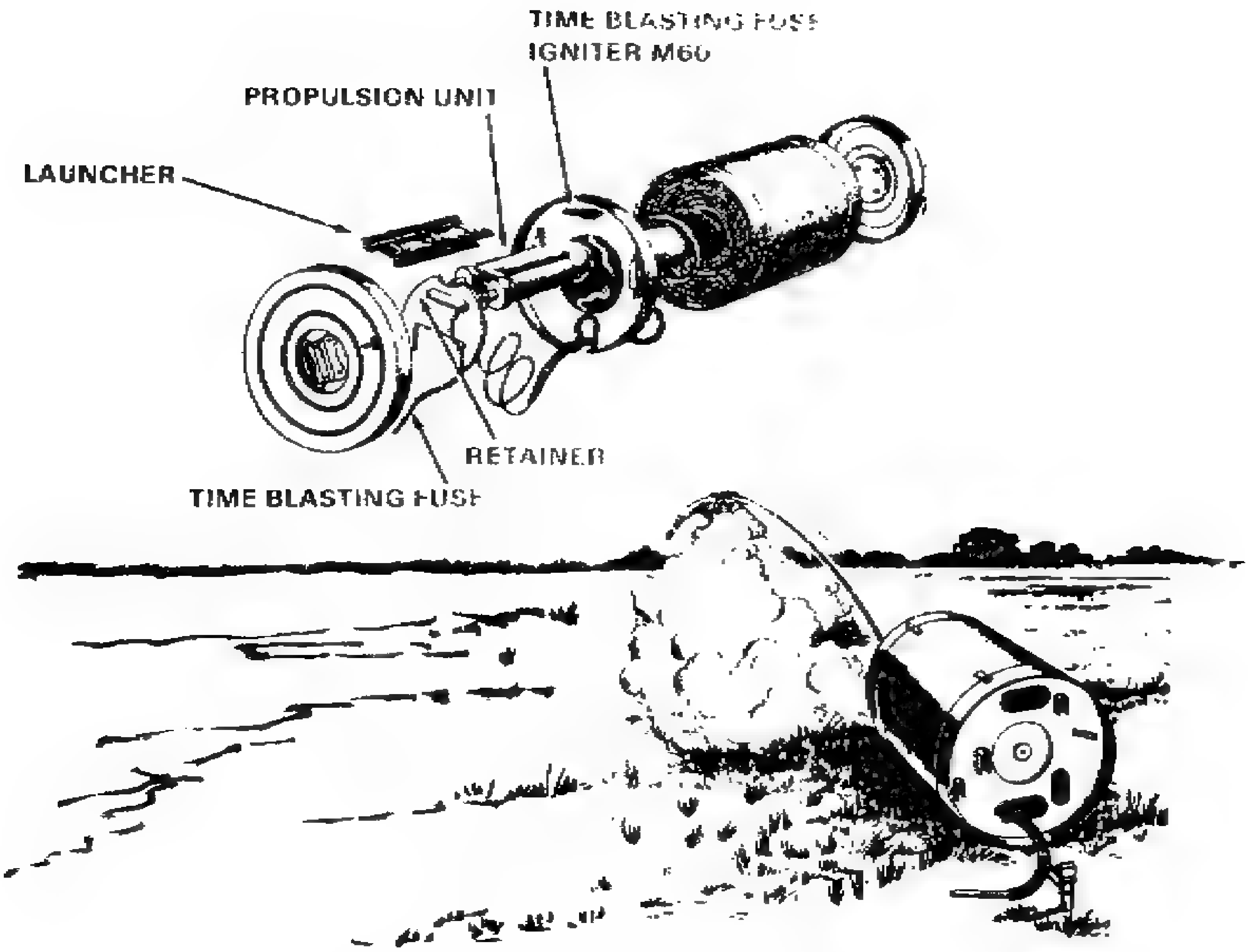


Figure 1-11. M1E1 projected charge kit

This kit is emplaced to project and detonate a cable across a pressure-actuated antipersonnel minefield. Grass, leaves, other light vegetation, and some soil are blown aside in a lane about 8 feet wide. More soil is blasted aside when the ground is moist and soft than when it is dry and hard. Camouflaged antipersonnel mines and those near the surface in the 8-foot lane are usually exposed. These kits are not effective against other types of obstacles.

Two soldiers are required to emplace and fire the kit. After emplacing the kit and choosing an area about 100 feet behind the kit offering cover to the soldier in a prone position, one soldier takes cover; the igniter for the rocket is functioned by the other soldier. In older kits, this soldier then moves to and functions the delay detonator for the detonating cable, then takes cover. In newer kits, the soldier takes cover immediately after functioning the igniter, and the delay detonator is then functioned from cover by means of a lanyard after the rocket fires.

The complete assembly is issued in an olive-drab-colored waterproof aluminum carrying case. Each case is sealed in a barrier bag and packed in a wooded box 25½ by 18⅜ by 19¼ inches. The gross weight of the kit and box is 142 pounds.

M157 projected charge demolition kit (antitank mine-clearing). This demolition kit is an antitank mine-clearing device designed to be towed and pushed for emplacement by a medium tank with accessories (Figure 1-12). For a complete physical description and maintenance instructions for this kit, see TM 9-1375-204-10 and TM 43-0001-38.

The kit is about 12 inches wide, 7 inches high, and 400 feet (121.9 meters) long. It consists of 79 sections: 1 nose section, 13 body sections, 62 center-loading sections, 2 impact fuze sections, and 1 tail section. Only 64 of the 79 sections contain explosives (62 center-loading sections; 2 impact fuze sections). The kit weighs 11,000 pounds including approximately 3,200 pounds of explosive. The explosive is a linear-shaped charge, 12 inches wide, 7 inches high, and 5 feet long, containing approximately 45 pounds of Composition B and 5 pounds of Composition C4. As the insert tubes are welded to the walls of the center-loading sections, the explosive elements cannot be used as separate charges or replaced by any substitute item in the field.

The demolition kit is designed to clear a path 100 meters long and 4 to 5 meters wide for vehicles and personnel to travel through minefields planted with single-impulse and pressure-type antitank mines. The kit is also effective against bands of log posts, steel rail posts, antitank ditches, and small concrete obstacles.

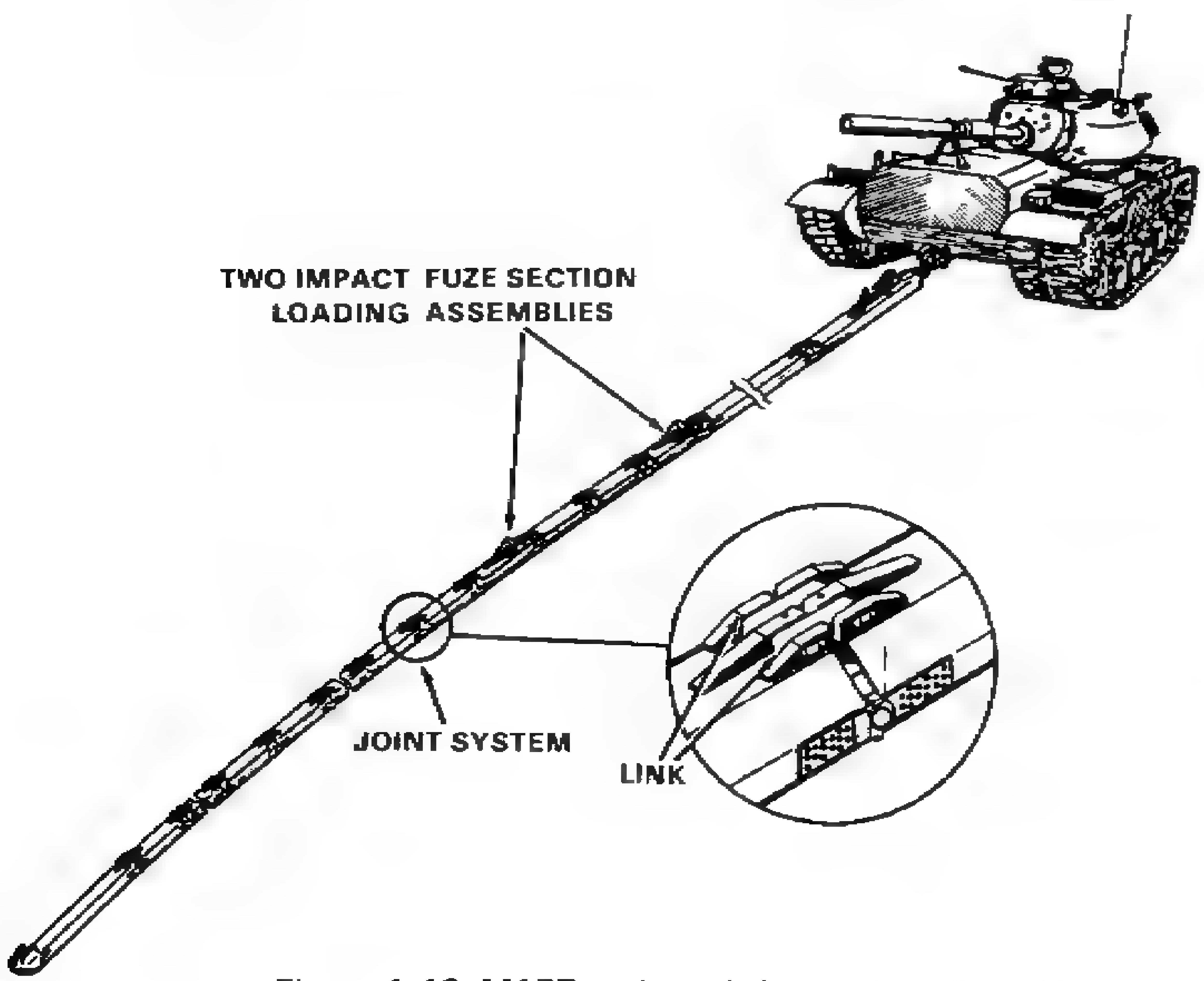


Figure 1-12. M157 projected charge demolition kit

If a ditch is unrevetted and 5 feet deep or less, and if the charge projects beyond the far side of the ditch, the charge will break down the sides of the ditch. This allows clearance for tank traffic.

The charge is detonated from a tank by means of bullet impact fuzes. The fuzes have a target plate that bears on the firing pin and is held in place by a shear pin and a safety fork that must be removed before the fuzes can be actuated. The fuzes are detonated by fire from the tank's machine guns. Two fuzes are provided to ensure that one is visible to the tank gunner at all times.

M173 projected charge demolition kit (antitank mine-clearing). The kit consists of a waterproof skid M3, a linear charge propulsion system, a linear demolition charge, and the necessary accessories to tow and fire the kit (Figure 1-13). The kit is 24 inches high, 56.5 inches wide, and 145 inches long. It weighs approximately 3,100 pounds. The linear demolition charge M96 is 300 feet long and contains 1,500 pounds of Composition C4 explosive. The kit clears a path 4 meters wide by 70 meters long. For a complete description of assembly procedures and operating and maintenance instructions, see TM 9-1375-202-10.

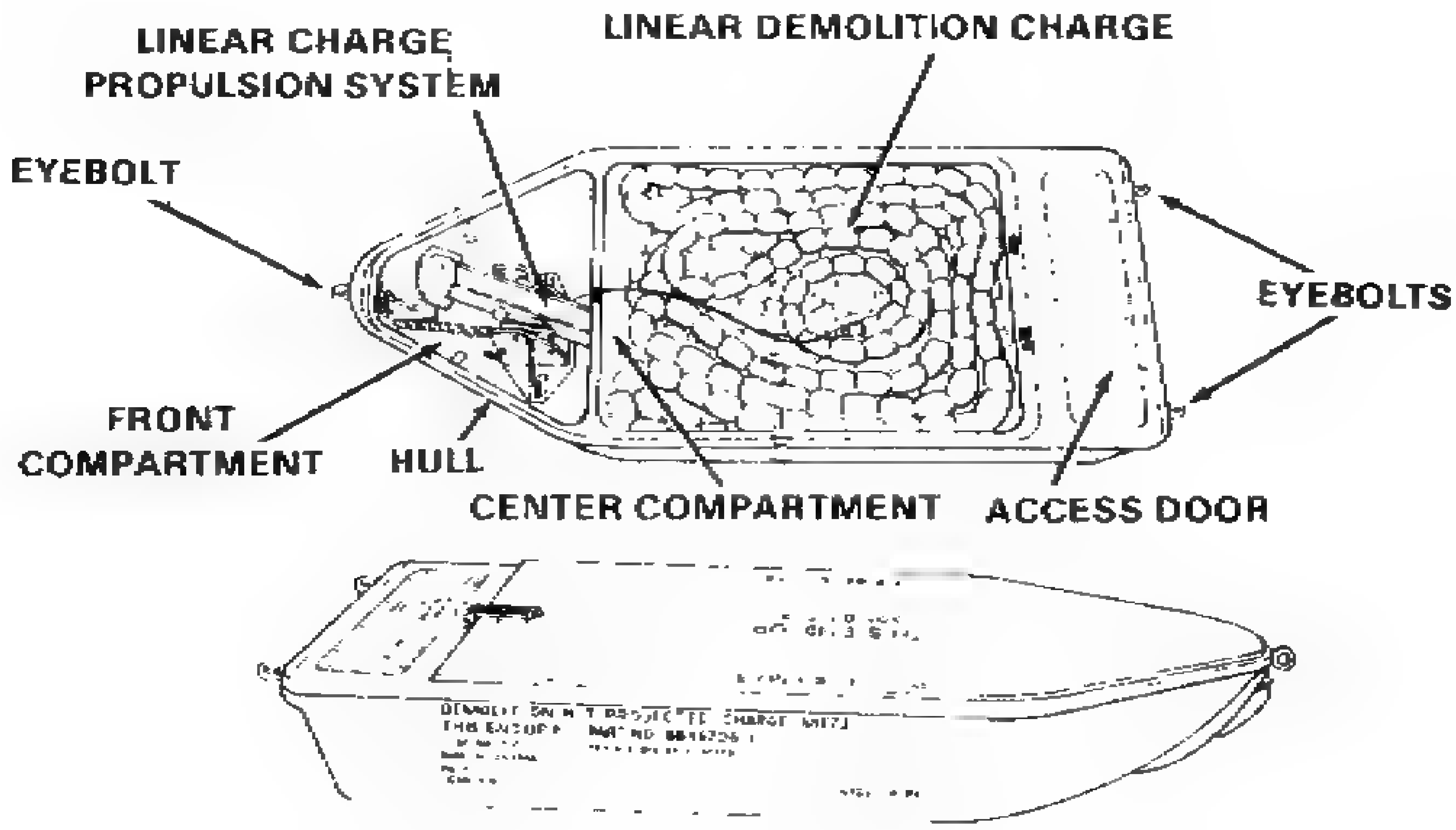


Figure 1-13. M173 projected charge demolition kit with main cover removed

The M173 projected charge demolition kit is an antitank minefield-clearing device designed to be towed by a vehicle to the edge of a minefield. A rocket will project the linear demolition charge across the minefield, while the subsequent detonation will clear a path in minefields planted with single-impulse and pressure-type mines.

Kit detonation can be done electrically from any vehicle containing a suitable 24-volt direct current bayonet type of outlet.

Mine-clearing line charge (MICLIC) kit. This kit consists of a launcher with firing kit, a 350-foot linear demolition charge (Composition C4), and a 5-inch rocket for projecting the linear charge across the minefield (Figure 1-14). The MICLIC will be mounted on a separately authorized standard 3½-ton capacity trailer chassis (M353). For a complete description of assembly procedures, operational description, and maintenance instructions for the kit, see TM 9-1375-215-14&P.

The MICLIC is an antitank/antivehicle mine-clearing device designed to be towed and positioned approximately 50 meters from the leading edge of the Threat minefield. The charge is then detonated to clear a path approximately 5 meters wide and 100 meters long.

Detonation is done by means of a blasting machine and firing control switch that are used to fire the rocket and detonate the linear charge after the linear charge is resting across the minefield.

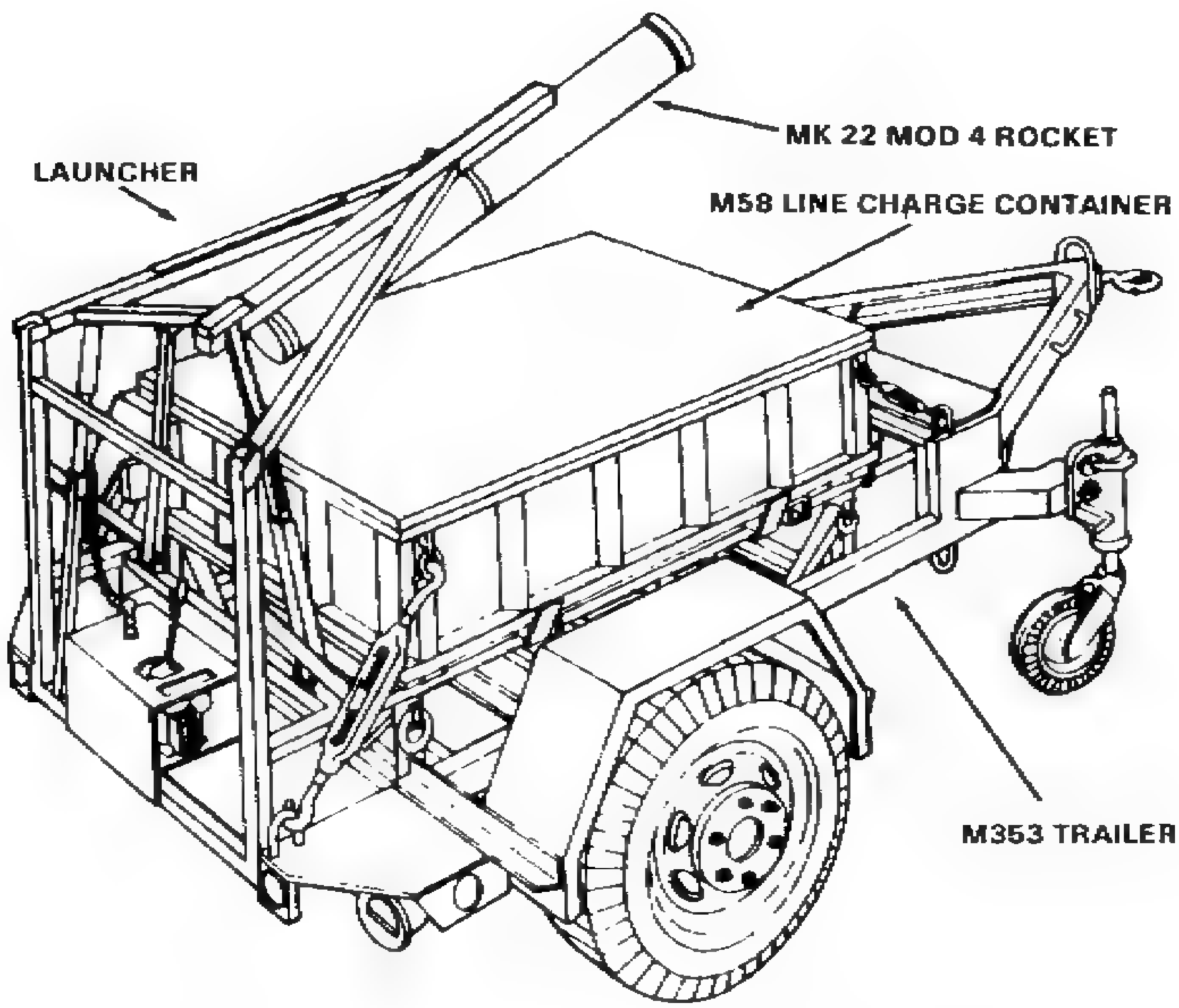
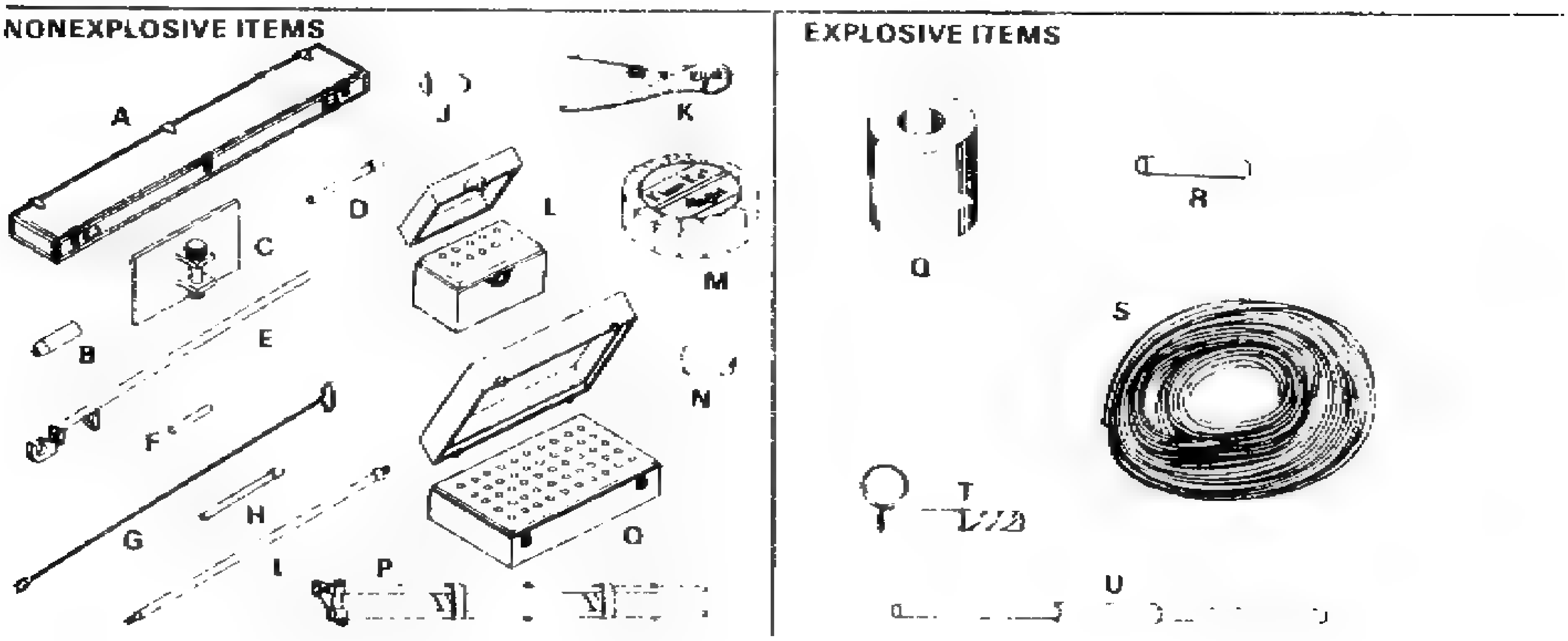


Figure 1-14. Mine-clearing line charge (MICLIC) kit

Explosive Earth Rod Kit

Characteristics. The earth rod kit is a special explosive kit used to make holes 6 feet deep and several inches in diameter in earth or soft shale for demolitions or construction (Figure 1-15). It is not usable in frozen ground, rock, or other hard material. A 6-foot long steel rod with point and firing chamber is driven into the earth by the propelling charge, which is exploded in the firing chamber. Use a removable handle (extractor rod), which fits through the holes in the firing chamber, and an extension for gripping and lifting the rod from the earth. A linear demolition charge is provided for enlarging the diameter of the hole. A forked insertion rod is also provided for insertion of improvised linear charges (made up of a bundle of detonating cords) when the standard ones are not available (see TM 43-0001-38).



NOTE: The letters in the figure correspond to the item letters in the lists.

Item Letter	Quantity	Item	Item Letter	Quantity	Item
A	1	Chest	Q	100	Charge, propelling, earth rod, M12 (w/primer, M44)
B	1	Chamber, firing			
C	1	Plate, base extractor, assembly	R	100	Cap, blasting, special, nonelectric, M7
D	1	Rod, extension	S	2	Fuse, blasting, time 50 foot coil
E	1	Extractor, rod	T	200	Igniter, time blasting fuse, M60, weatherproof
F	1	Rod, handle and starting			
G	1	Rod, inserting	U	100	Charge, demolition, linear (two 3-foot sections and one connecting sleeve)
H	2	Rod, intermediate			
I	2	Rod, main, long			
J	100	Adapter, priming, explosive, M1A4			
K	1	Crimper, cap, M2 (w/ fuse cutter)			
L	1	Box, cap, 10 cap capacity, infantry			
M	2	Insulation tape, electrical, black adhesive cotton, ¾ inch wide			
N	100	Point			
O	2	Box, cap, 50 cap capacity, engineer			
P	1	Tripod			

Figure 1-15. Earth rod kit

M180 Demolition Kit (Cratering)

Characteristics. The kit consists of an M2A4 shaped charge, a modified M57 electrical firing device, a warhead, a rocket motor, a tripod assembly, and a demolition circuit (Figure 1-16). The shaped charge, firing device, and warhead are permanently attached to the launch leg of the tripod. The rocket motor and the demolition circuit (packaged in a wooden subpack) are shipped unattached and connected to other components at the time of use. The kit weighs approximately 165 pounds (74.25 kilograms). For additional assembly procedures, operational description, and maintenance instructions for the kit, see TM 9-1375-213-12-1.

Use. The kit is designed to produce a large crater in compacted soil or road surfaces, including reinforced concrete. The only exceptions are arctic tundra and bedrock or sandy soil in other regions. The kit produces its crater in two stages. First, the shaped charge blows a pilot hole in the surface, and then the rocket-propelled warhead enters the hole and detonates, enlarging the pilot hole. A number of kits can be fired together to produce an exceptionally large crater.

Detonation. A 50-cap blasting machine (M34) is used to fire the kit.

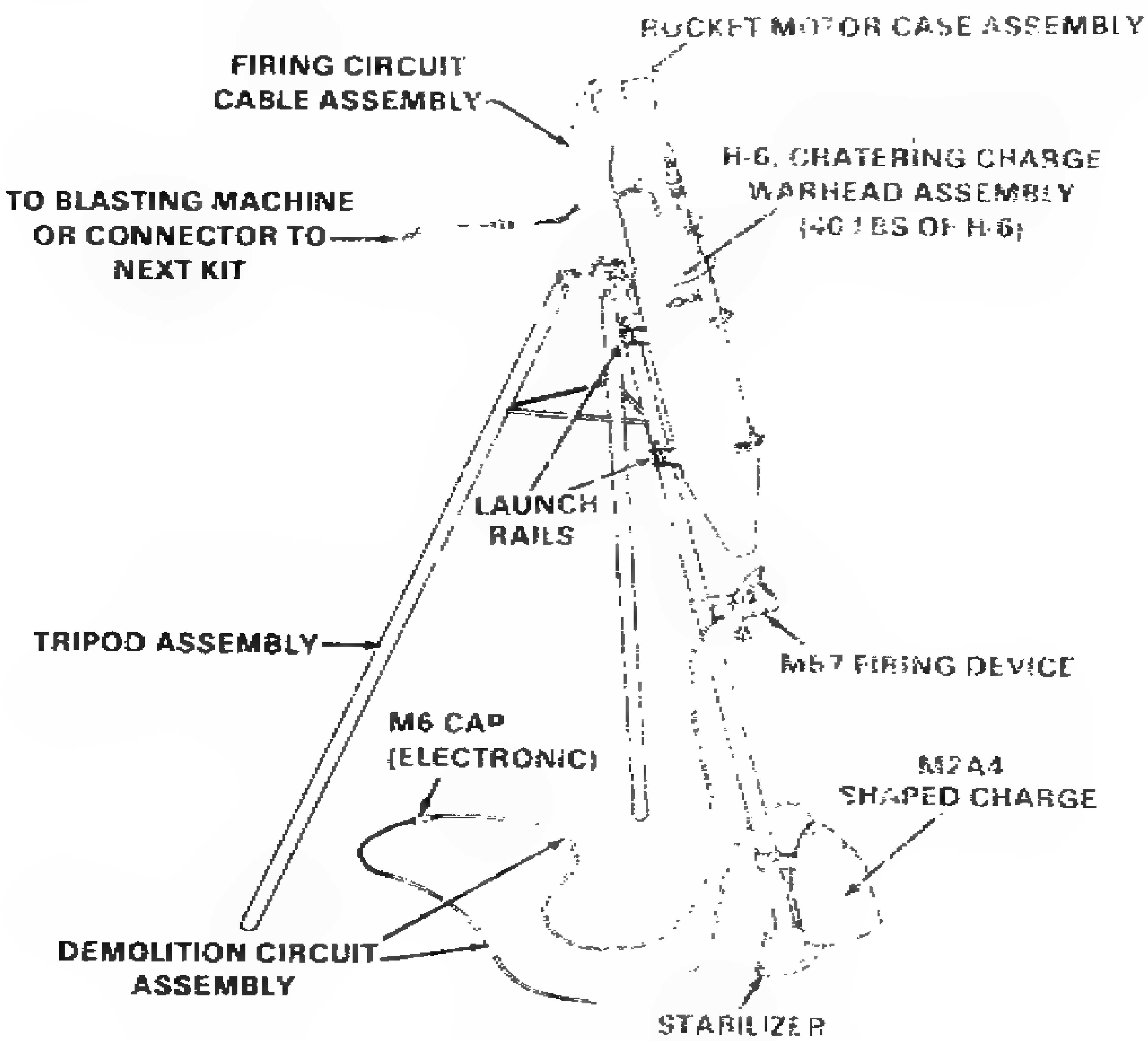


Figure 1-16. M180 demolition kit assembly

The time blasting fuse transmits a flame ... to a nonelectric

[illegible]

Safety fuse. [illegible]

... the most common (figure 1 17). The burning rate [illegible]

M700 time fuse ... 0.2 inches in diameter with a plastic cover (figure 1 18) [illegible]

Packaging. Safety fuse is packaged in 50-foot coils ... in a wooden box 24¼ by 15 ... by 12 ... inches. The [illegible]

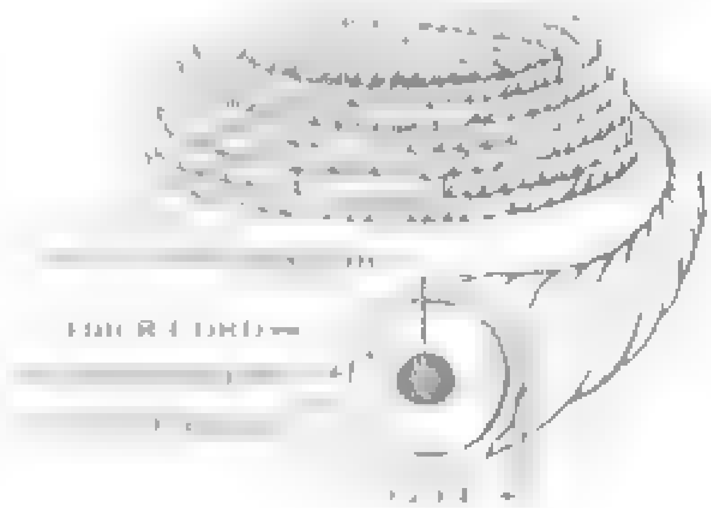


Figure 1 17. Safety fuse

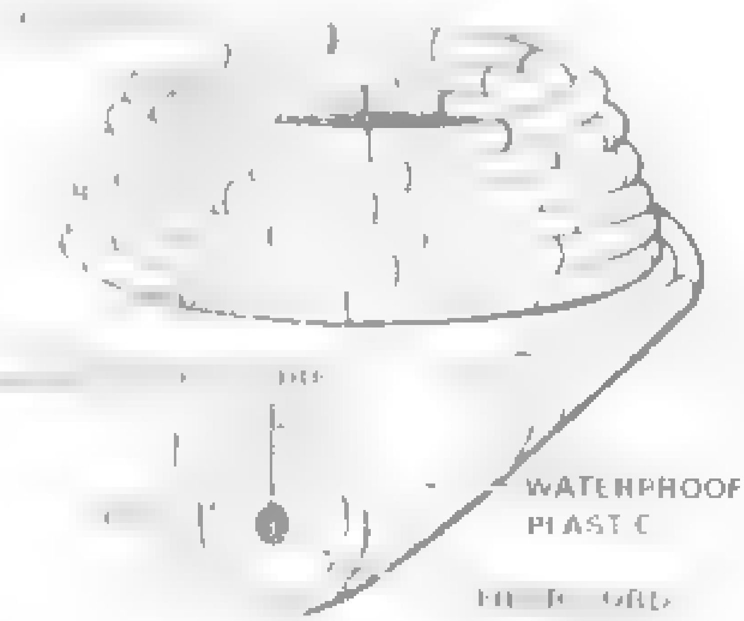


Figure 1 18. M700 time fuse

[illegible]

Detonating Cord

Characteristics. Detonating cord is a core of PETN or RDX in a textile tube coated with a thin layer of asphalt. On top of this is an outer textile cover finished with a wax gum composition or plastic coating (Figure 1-19). It will transmit a detonating wave from one point to another at a rate between 20,000 and 24,000 feet per second. A partially submerged water-soaked detonating cord will detonate if initiated from a dry end. Although it does not lose its explosive properties by exposure to low temperatures, the covering becomes stiff and cracks when bent. Great care is required in using detonating cord primers in arctic conditions. Data on the types available are shown in Table 1-6.

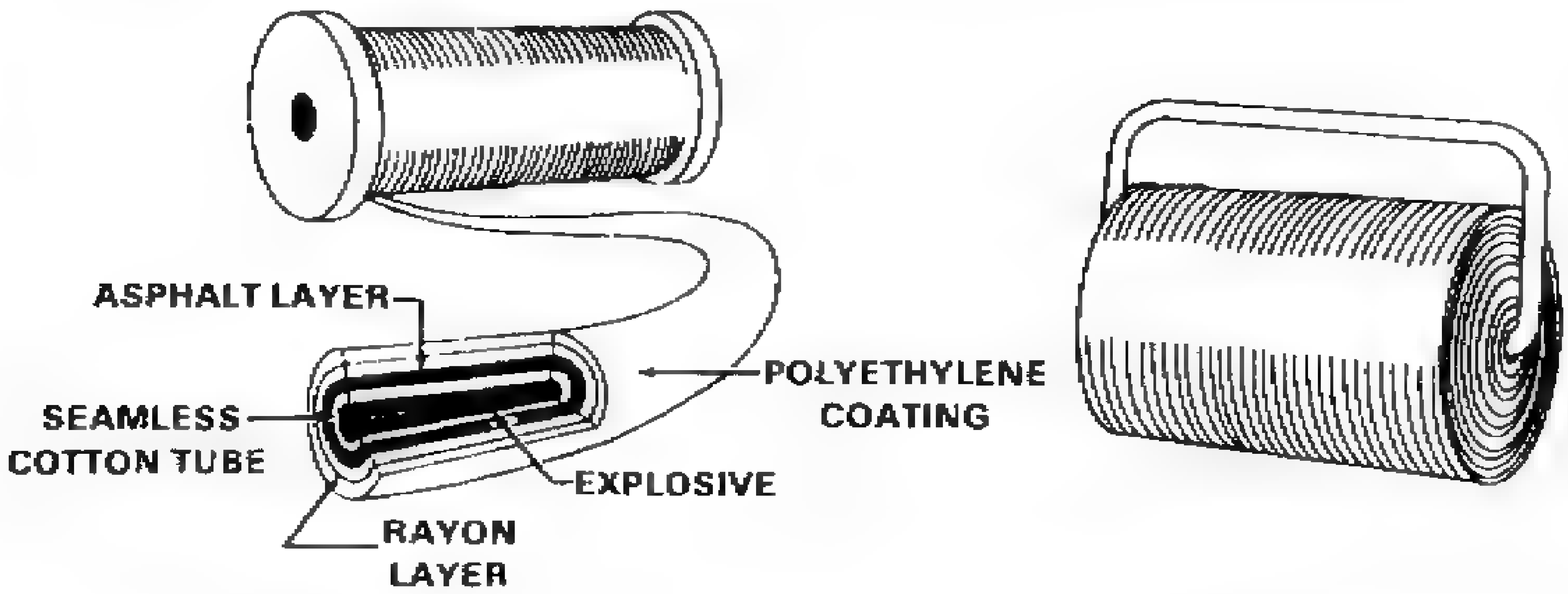


Figure 1-19. Reinforced Pliofilm-wrapped detonating cord

Use. Use detonating cord to prime and detonate other explosive charges. When its explosive core is detonated by a blasting cap or other explosive device, it will transmit the detonation wave to an unlimited number of explosive charges. This is explained in full detail in Chapter 2.

Table 1-6. Detonating cord data

Type	Class	Minimum weight of explosive core per 1,000 ft	Nominal diameter, in	Maximum weight (lb) of finished cord per 1,000 ft	Minimum breaking strength, lb
I	a	5 pounds PETN	0.175	14	60
I	b	6 pounds PETN	0.216	19	175
*I	c	6.4 pounds PETN	0.200	18	175
I	d	7 pounds PETN	0.200	19	110
I	e	7 pounds PETN	0.235	22	190
I	f	12.5 pounds PETN	0.245	26	75
I	g	12.5 pounds PETN	0.270	33	190
I	h	14.5 pounds PETN	0.235	29.5	110
I	i	6.4 pounds PETN	0.200	18	150
II	a	7 pounds RDX	0.216	19	175
II	b	8.5 pounds RDX	0.255	22	190
III		All Type III detonating cord is inert loaded with a PVC filler.			

* This detonating cord (Type I, class c) has been agreed upon as "standard" within the American British-Canadian Australian Standardization Program

Precautions. The ends of detonating cord should be sealed with a waterproof sealing compound to keep out moisture when used to detonate underwater charges or charges left in place several hours before firing. A 6 inch free end will also protect the remainder of a line from moisture for 24 hours. Avoid kinks or short bends in priming, as they may sharply change the direction of detonation and cause misfires.

Blasting Caps

Blasting caps are used for detonating high explosives. There are two types of blasting caps—electric and nonelectric. They are designed for insertion into cap wells and are also the detonating element in certain firing devices. Blasting caps are rated in power according to the size of their main charge. Commercial blasting caps are normally No 6 or No 8 and are used to detonate the more sensitive explosives such as commercial dynamite and tetryl. Special military blasting caps (M6 electric and M7 nonelectric) or their commercial counterparts (J1 electric and J2 nonelectric) are used to ensure positive detonation of the generally less sensitive military explosives. Their main charge is approximately double that of the commercial No 8 blasting cap. Both military and commercial blasting caps are extremely sensitive and may explode unless handled carefully. They must not be tampered with and must be protected from shock and extreme heat. Separate blasting caps properly. Never store them with other explosives. They should not be carried in the same truck except in an emergency (see Chapter 5, Transportation Regulations).

Electric blasting caps. Use electric blasting caps when a source of electricity, such as a blasting machine or a battery, is available. Two types of caps are used—military and commercial. Military caps, shown in Figure 1-20, are instantaneous. Commercial caps are either instantaneous or delay. Commercial delay caps are available with delays ranging from 0.025 second to 12 seconds.

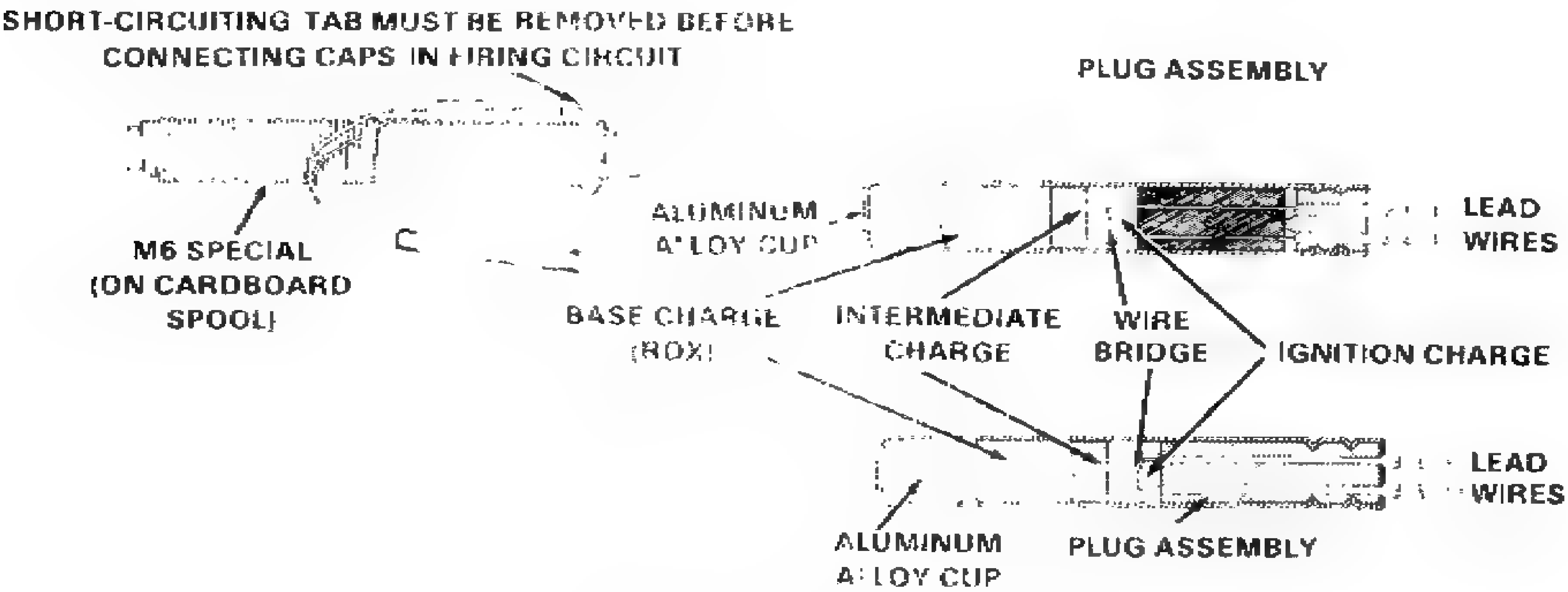


Figure 1-20. Electric blasting caps

Commercial delay caps used in military applications have delays ranging from 1 00 second to 1.53 seconds. Electric caps have lead wires of various lengths for connection into a circuit. The lead wires most commonly used are 12 feet long. For ignition, electric caps require one and one-half amperes of electricity passing through their wires. The M6 special electric blasting cap is the standard issue electric blasting cap. For additional information, see TM 43-0001-38.

WARNING

Do not remove the short-circuiting shunt before testing or connecting the cap to prevent accidental initiation by static electricity. Twist the bare ends of the lead wires together at least three 180-degree turns to provide the shunting action if the cap has no shunt.

Nonelectric blasting caps. These caps may be initiated by a time blasting fuse, firing device, and detonating cord (Figure 1-21). **Do not** use nonelectric blasting

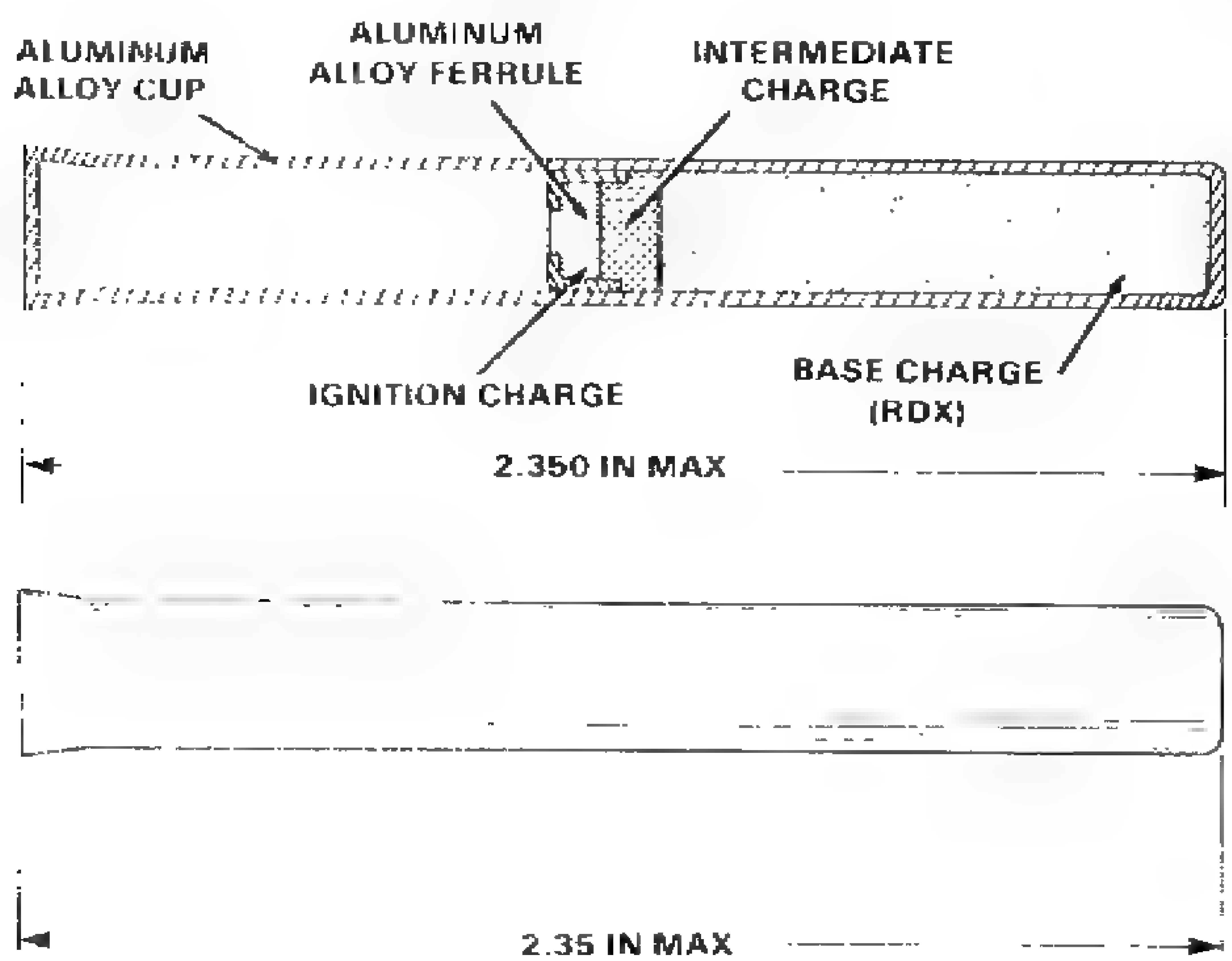


Figure 1-21 Nonelectric blasting cap

caps to prime charges placed underwater or in wet boreholes because they are difficult to waterproof. If it is necessary, moisture-proof nonelectric blasting caps with a waterproof sealing compound. The most commonly used nonelectric blasting caps are commercial J1, No 6 and No 8, and military special nonelectric M7. The M7 special nonelectric blasting caps are flared at the open end for easy insertion of the time fuse. For additional information, see TM 43-0001-38.

M1A4 Priming Adapter

The M1A4 priming adapter is a plastic hexagonal-shaped device threaded to fit threaded cap wells and the M10 universal explosive destructor. A shoulder inside the threaded end is large enough for a time blasting fuse and detonating cord but too small for a military blasting cap. The adapter is slotted lengthwise to permit easy and quick insertion of the electric blasting cap lead wires (Figure 1-22). The M1A4 replaces the M1A2 and M1A3 models, which have cylindrical bodies. The hexagonal M1A4 is easily handled by soldiers wearing arctic mittens.

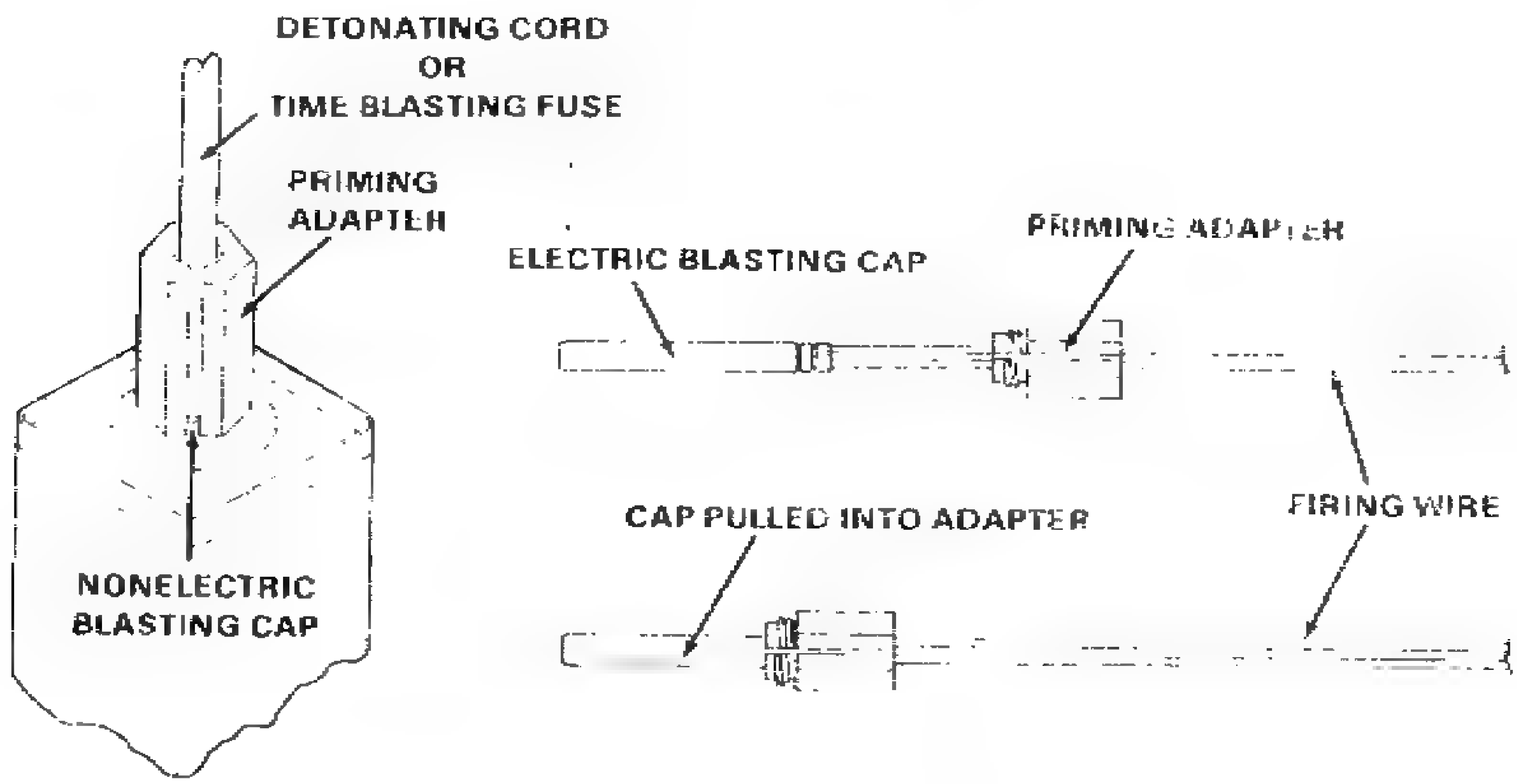


Figure 1-22. M1A4 priming adapter

M8 Blasting Cap Holder

The M8 blasting cap holder is a metal clip designed to attach and hold a blasting cap to sheet explosive (Figure 1-23). It is supplied with the M118 sheet demolition charges and the M186 roll demolition charge. The M8 blasting cap holder is also available as a separate item of issue in quantities of 4,000.

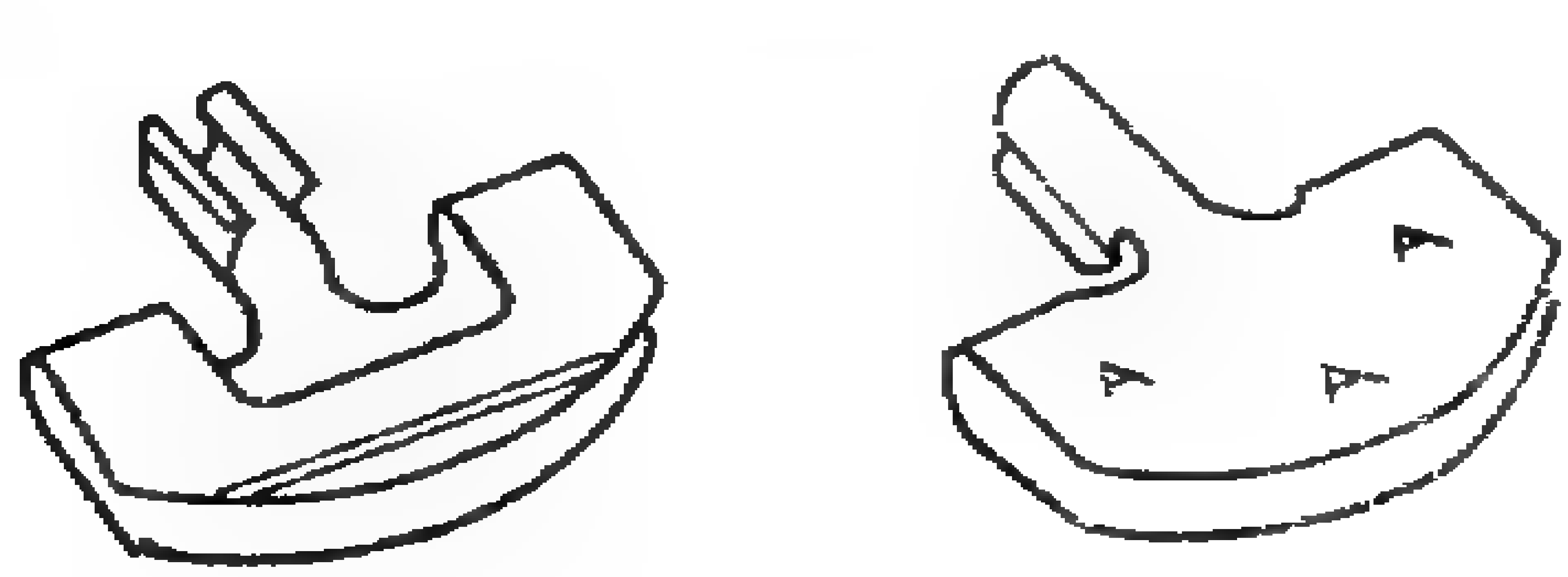


Figure 1-23. M8 blasting cap holder

M1 Adhesive Paste

The M1 adhesive paste is a sticky, putty like substance which is used for attaching charges to vertical or overhead flat surfaces. It is useful in holding charges while tying them in place or, under some conditions, for holding without tying. It does not adhere satisfactorily to dirty, dusty, wet, or oily surfaces. It becomes stiff and hard while losing its adhesiveness at subzero temperatures. It is softened by water, becoming useless.

Pressure-Sensitive Adhesive Tape

Characteristics. This pressure sensitive tape is replacing M1 adhesive paste and is superior in speed and ease of application as well as holding power. It is used to hold demolition charges to dry and clean wood, steel, or concrete.

Use. The tape is coated on both sides with pressure sensitive adhesive and requires no solvent or heat to apply. It is available in rolls 2 inches wide and 72 yards long.

Limitations. This tape does not adhere to dirty, wet, or oily surfaces and is not to be used when the surface temperature of the target is below freezing.

Supplementary Adhesive for Demolition Charge

Characteristics. The supplementary adhesive is used to hold demolition charges when the target surface is below freezing, wet, or underwater. The adhesive is issued in a tube in water-resistant cardboard slide boxes, packaged with wooden applicators, and shipped 150 boxes in a fiber-board container (Figure 1-24).

Use. Apply the adhesive to the target surface with a wooden applicator and a demolition block with or without pressure sensitive tape placed on top.

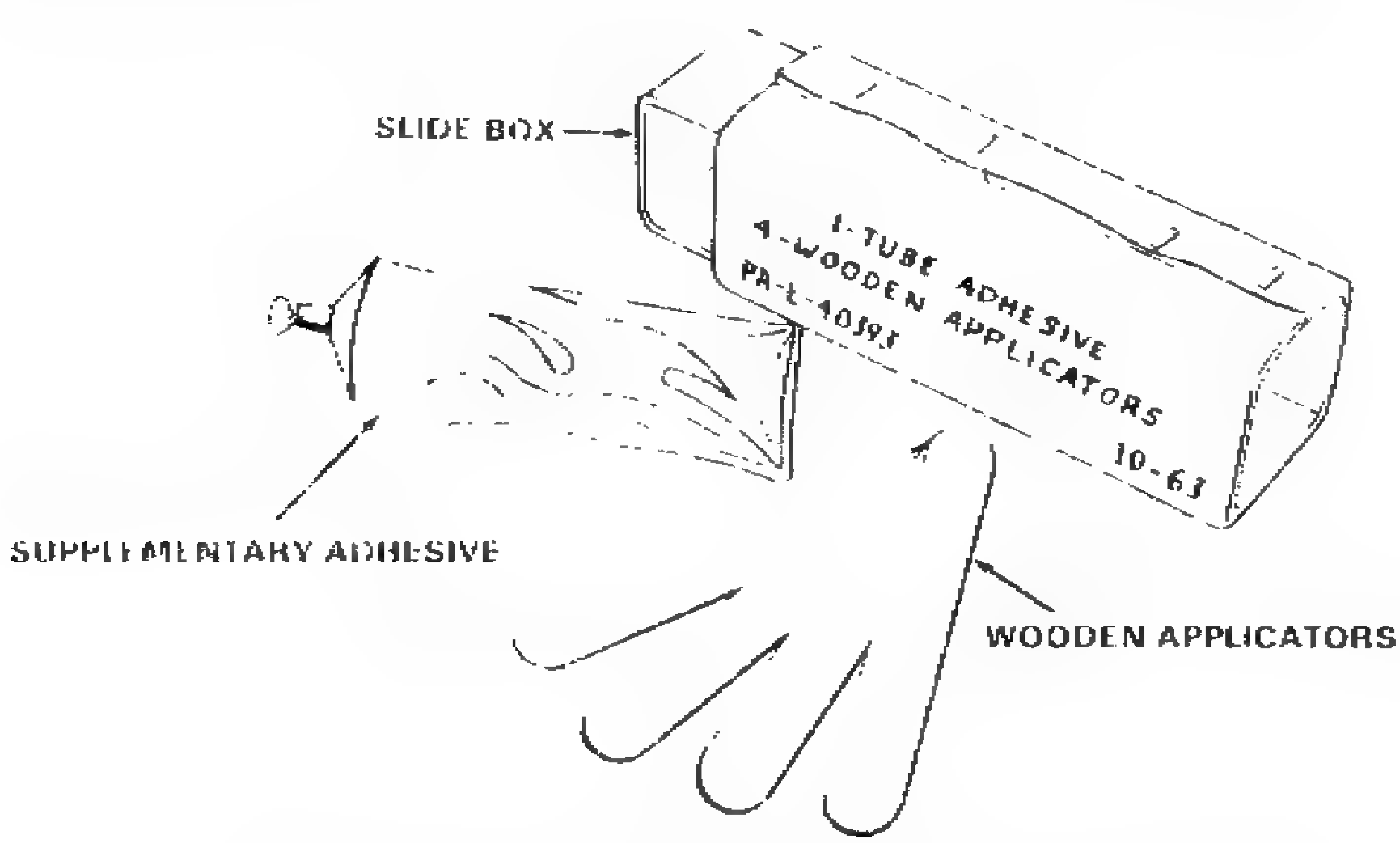


Figure 1-24. Supplementary adhesive for demolition charge

Waterproof Sealing Compound

The sealant is used to waterproof the connection between the time blasting fuse and a nonelectric blasting cap and to moisture-proof primed dynamite. It will not make a permanent waterproof seal and must not be submerged in water unless the charge is to be fired immediately.

M2 Cap Crimper

The M2 cap crimper (Figure 1-25) is used to squeeze the shell of a nonelectric blasting cap around a time blasting fuse, a standard base, or detonating cord securely enough to keep it from being pulled off but not tightly enough to interfere with the burning of the powder train in the fuse or the detonation of the detonating cord. A stop on the handle limits the closing of the jaws to prevent this. The M2 crimper forms a water-resistant groove completely around the blasting cap. Apply a sealing compound to the crimped end of the blasting cap for use underwater. The rear portion of each jaw is shaped and sharpened for cutting fuses and detonating cords. One leg of the handle is pointed to use in punching cap wells in explosive materials for easy insertion of the blasting caps. The other leg has a screwdriver end. Cap crimpers are made of a soft nonsparking metal, which will conduct electricity, and must not be used as pliers because such use damages the crimping surface. Keep the cutting jaws clean and use them only for cutting fuses and detonating cords.

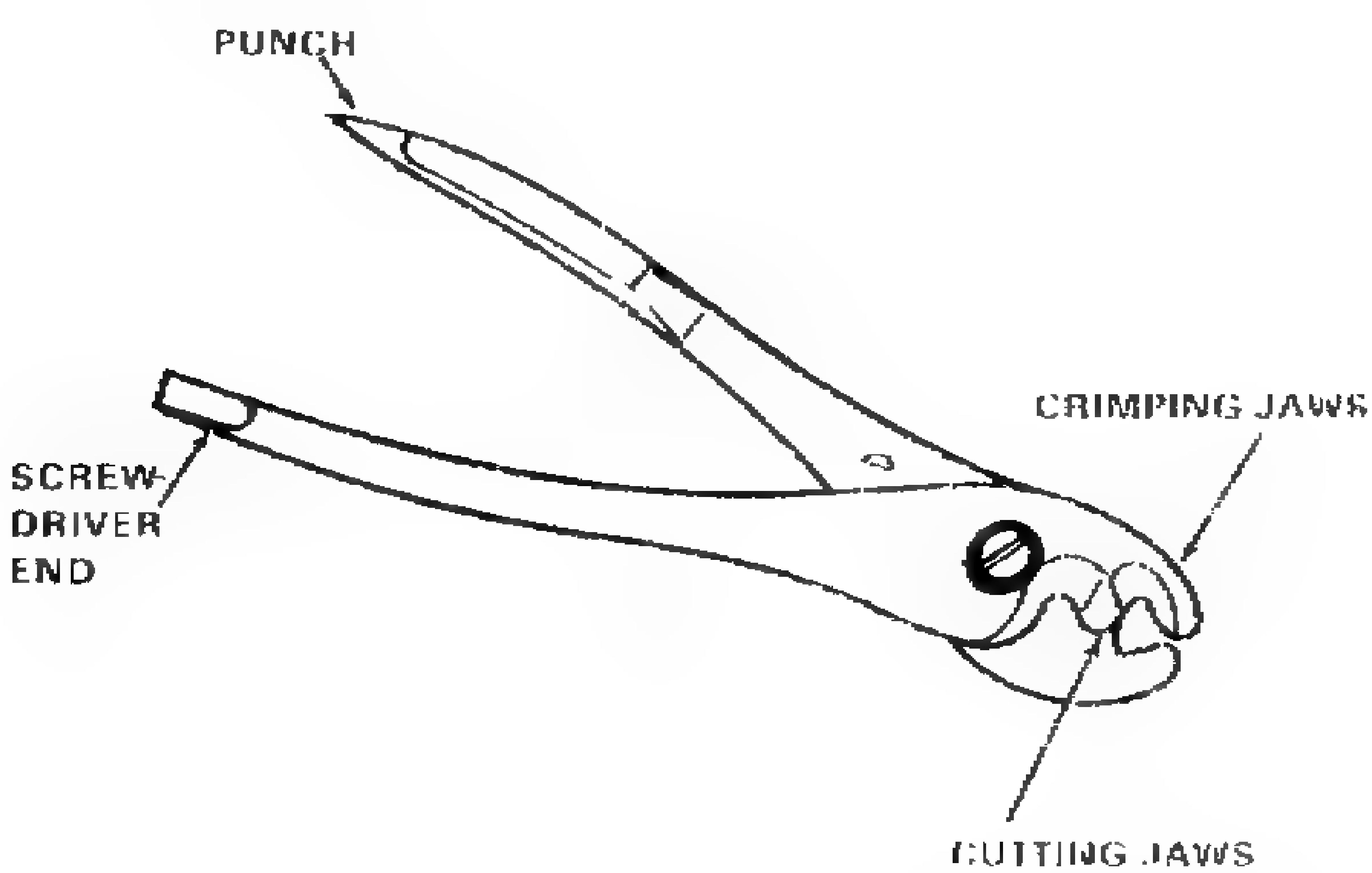


Figure 1-25. M2 cap crimper

Blasting Galvanometer

Use. Use the blasting galvanometer in testing the electric firing system to check the continuity of the circuit (the blasting cap, firing wire, wire connections, and

splices) in order to reduce the possibility of misfires (Figure 1-26). Its components include a d'arsonal movement meter and a small special silver chloride dry-cell battery. When the two external terminals are connected in a closed circuit, the flow of current from the dry cell moves the needle across the scale. The extent of the needle deflection depends on the amount of resistance in the closed circuit and on the strength of the battery. Handle the galvanometer carefully and keep it dry. Test the galvanometer before using by holding a piece of metal across its two terminals. If this does not cause a wide deflection of the needle (23 to 25 units), the battery is weak and should be replaced.

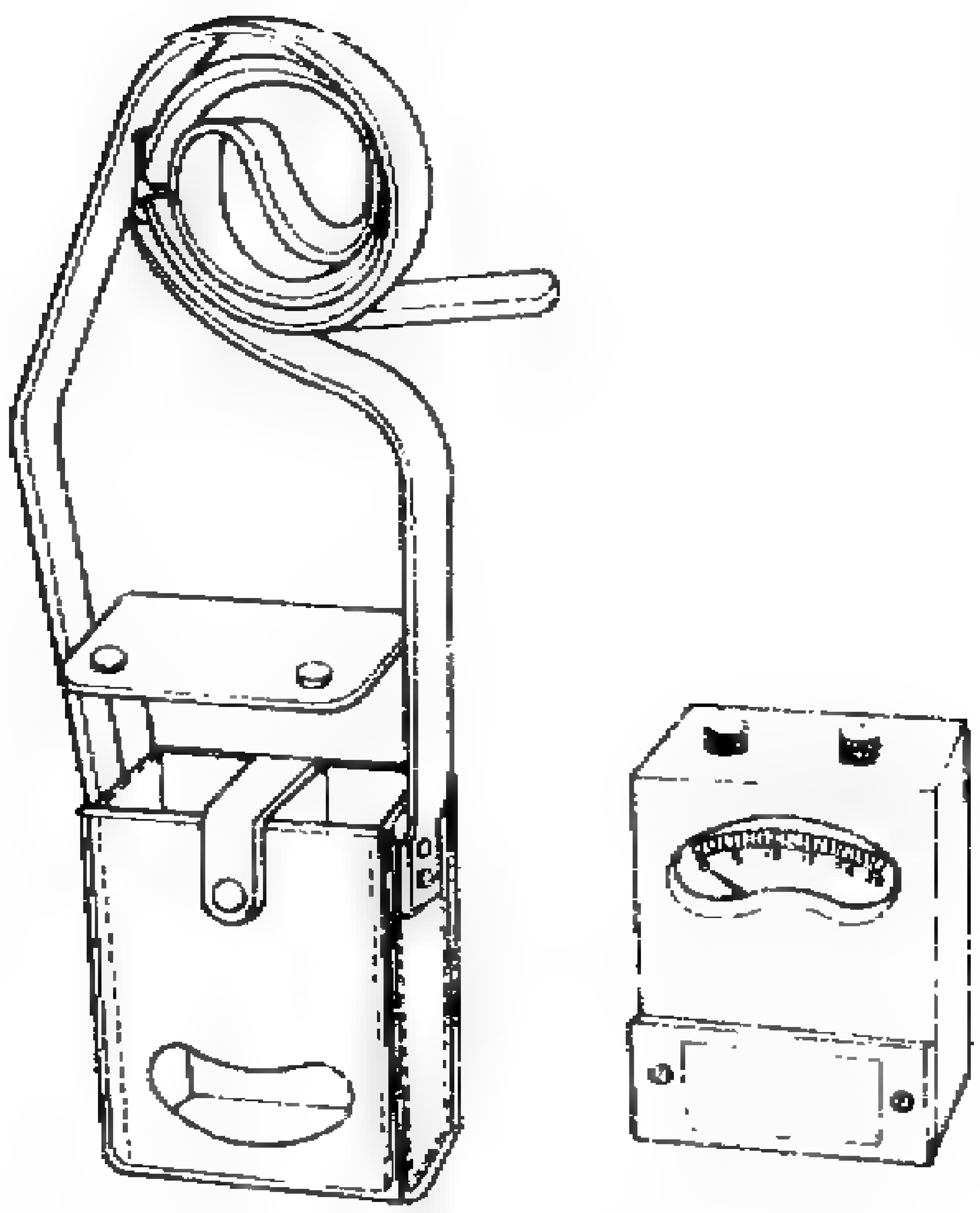


Figure 1-26. Blasting galvanometer

Battery Types. The two types of dry batteries authorized for use with this galvanometer are-

- BA-245/u Special Silver Chloride Dry-Cell, 0.9 volts total voltage; NSN 6135-00-128-1632, authorized for use at temperatures **above** 0 degrees Fahrenheit.
- BA-2245/u Special Silver Chloride Dry-Cell; 0.9 volts total voltage, NSN 6135-00-833-9909 authorized for use at temperatures **below** 0 degrees Fahrenheit.

Choice of battery. When using the galvanometer at extremely cold temperatures, low temperature battery BA-2245/u is recommended. Battery BA-245/u will freeze and cease to function at temperatures below 0 degrees Fahrenheit. If the BA-245/u is used at extremely cold temperatures, protect it from freezing by placing the galvanometer under the clothing near the body. When using a galvanometer at temperatures above 32 degrees Fahrenheit, use the BA-245/u battery. The BA-2245/u battery is a low-temperature battery, and it deteriorates rapidly at higher temperatures, even when not in use.

WARNING

Use only the two special silver-chloride dry-cell batteries BA-245/u and BA-2245/u, which produce only 0.9 volts, in the galvanometer, as other batteries may produce enough voltage to detonate electric blasting caps. Because of their tendency to corrode, the batteries should be removed from the galvanometer when it is not to be used for extended periods.

M51 Blasting Cap Test Set

Characteristics. The test set was developed to replace the blasting galvanometer for continuity testing of electrical firing circuits (Figure 1-27). The test set is a self-contained unit with a magnetotype impulse generator, an indicator lamp, a handle to activate the generator, and two binding posts for attachment of firing leads. The test set is waterproof and can be used at temperatures as low as -40 degrees Fahrenheit.

Use. Complete the continuity testing by connecting the firing circuit to the test set binding posts and then depressing the handle sharply. If there is a continuous (intact) circuit — even one created by a short — the indicator lamp will flash.

Maintenance. Handle the test set with care and keep it dry to assure optimum use. Before using, ensure that the set is in operating condition by following these steps:

- Connect a piece of bare wire or the legs of the M2 crimpers between the binding posts.
- Depress the handle sharply while observing the indicator lamp. If the set is operative, the lamp will flash.
- Remove the wire or the crimpers and proceed to test the firing circuit.

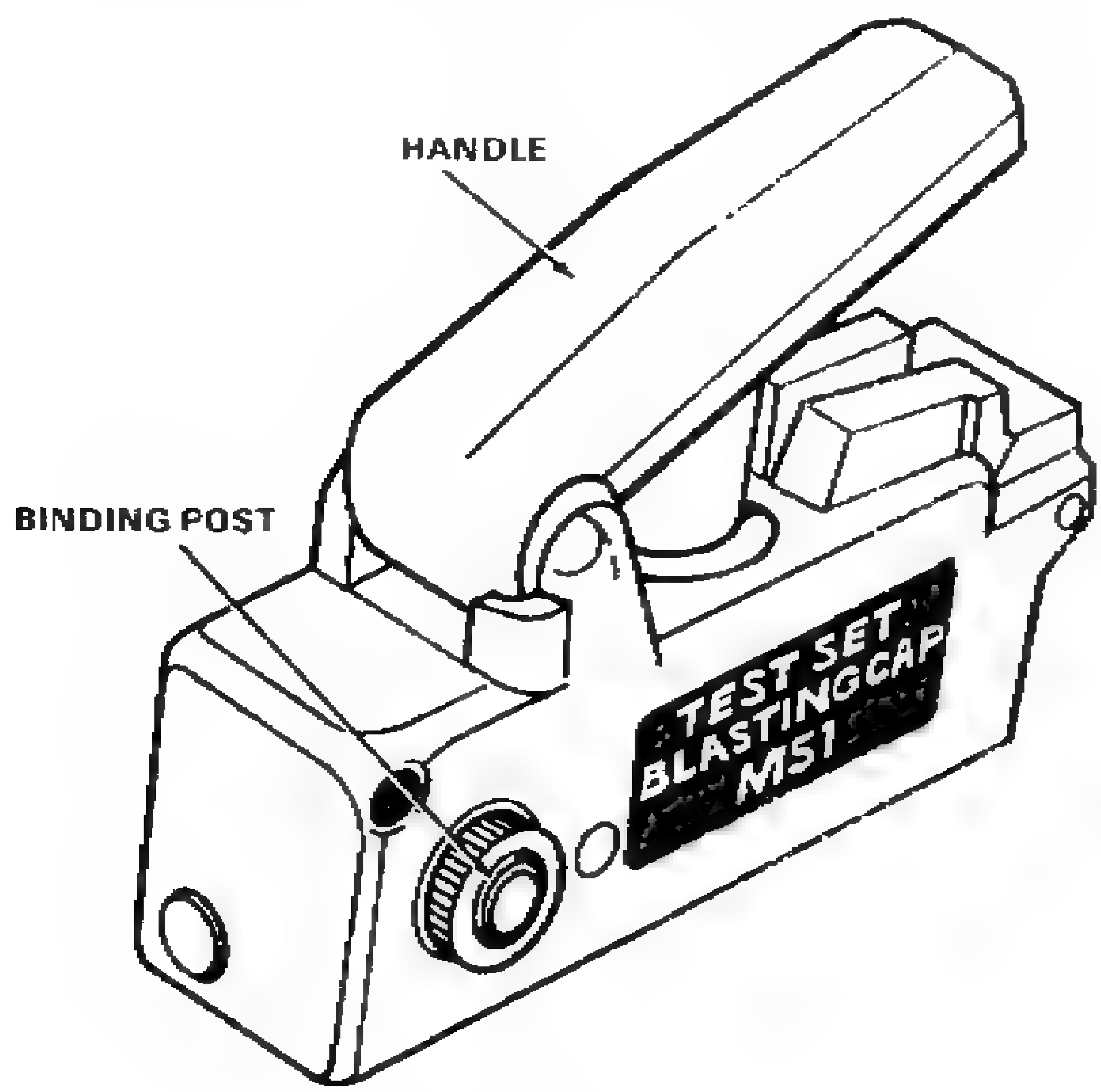


Figure 1-27. M51 blasting cap test set

Blasting Machines

Use the blasting machines and demolition firing devices to provide the electric impulse needed in electric blasting operations. The family of blasting machines includes six models—three models derive their power directly from a shunt-wound direct current (DC) generator; two models, the M32 and M34, derive their power from an alternator and use a capacitor discharge output circuit; and one model, the M122 demolition firing device, remotely initiates explosives by means of a coded radio signal radiated by its transmitter to the receiver located at or near the explosives.

Ten-cap blasting machine (older type). This small DC electrical generator produces adequate current (1.5 amperes) to initiate 10 electric caps, connected in series, if the handle is rotated to the end of its travel (Figure 1-28, A). The ten-cap blasting machine weighs approximately 5 pounds. To operate the machine, complete the following steps:

- Check the machine to ensure that it works properly before attaching the firing wires. Operate the machine several times until it works smoothly. Do this by inserting the handle. Then insert the left hand through the strap and grasp the bottom of the machine. Next, grasp the handle with the right hand and turn it vigorously clockwise as far as possible.
- Fasten the firing wires tightly to the terminals.

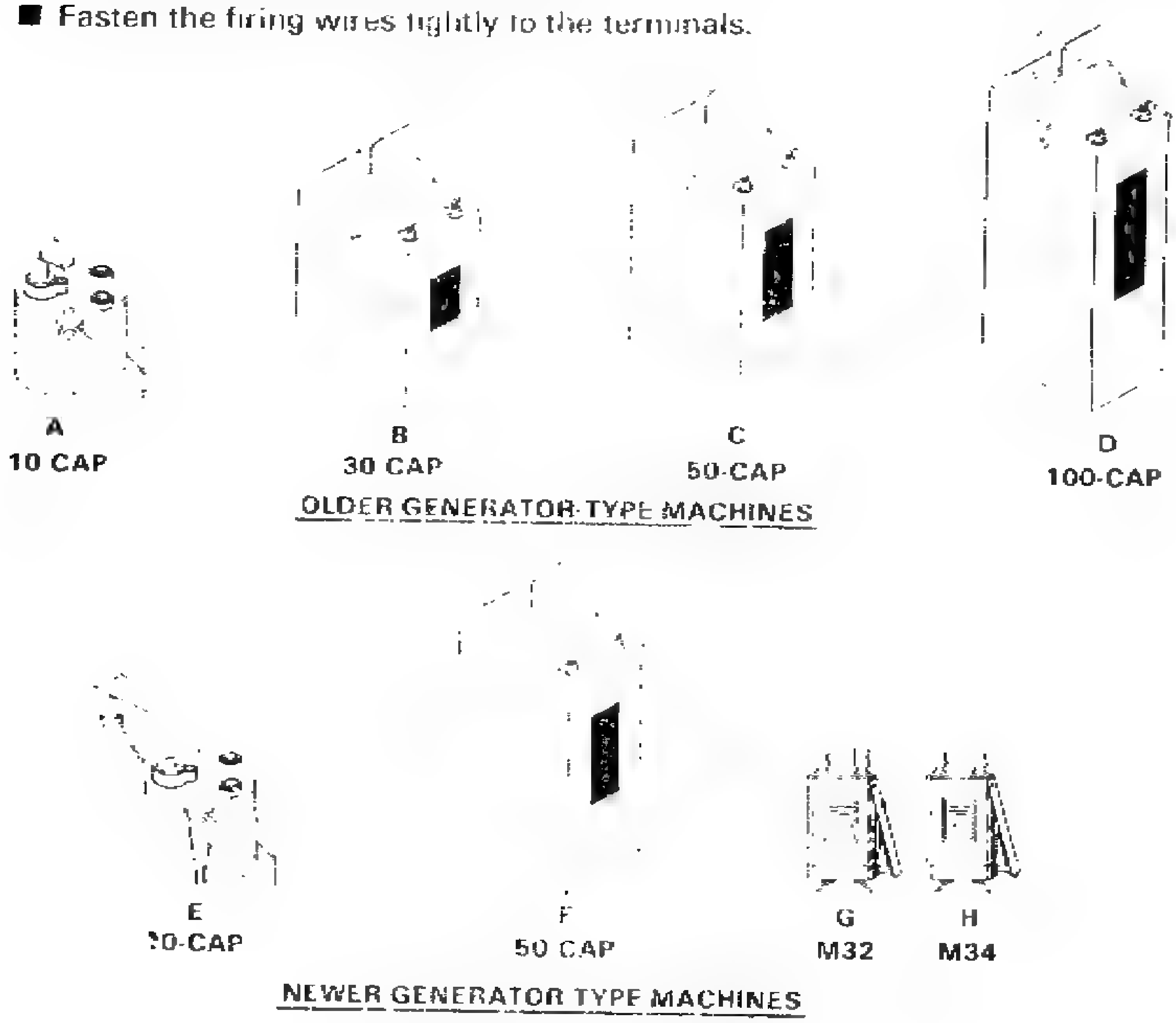


Figure 1-28. Blasting machines

M32 10-cap blasting machine. This small, lightweight blasting machine produces adequate current (1.5 amperes) to initiate 10 electrical caps connected in series (Figure 1-28, G). To operate the machine, complete the following steps:

- Check the machine to ensure that it works properly. Do this by successfully actuating the machine three or four times until the neon indicator lamp flashes. This light is located between the wire terminals of the machine.
- Release the blasting machine knob by rotating the O-ring until the handle springs outward from the body of the machine.
- Insert the firing wire leads into the terminals by pushing down on each terminal and inserting the leads into the metal jaws.
- Hold the machine upright (terminals up) in either hand, so the plunger end of the handle rests under the base of the thumb and the fingers grasp the machine's body (Figure 1-29, B).
- Squeeze the hand grip sharply several times in succession until the charge fires. No more than three or four strokes should be required.

Thirty-cap blasting machine. This device, shown in Figure 1-28, B, fires 30 electric caps connected in series. It weighs about 20 pounds. To operate the machine, proceed as follows:

- Raise the handle to the top of the stroke.
- Push the handle down quickly as far as it will go (Figure 1-29, C).

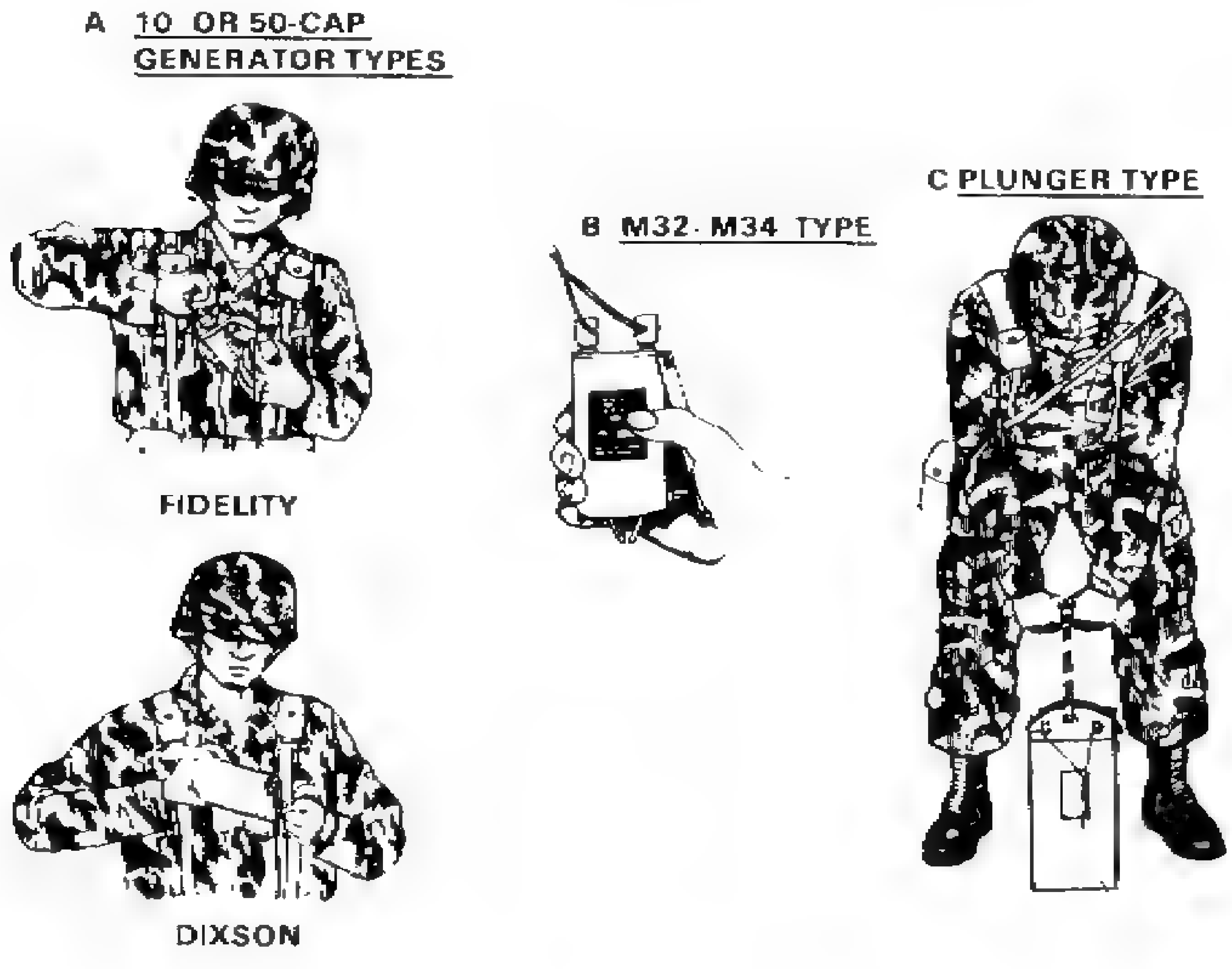


Figure 1-29. Actuating blasting machines

[illegible] series (figure 1-28, E, page 1-36). It weighs about 20 pounds. Test and operate [illegible]

M34 [illegible] 1-28, B, page 1-36). It looks like the M32 blasting machine except for a black [illegible] the M34 in the same way as the M[illegible].

[illegible] 1-28, D, on page 1-36) is similar to the 50-cap machine except for size and [illegible]

M122 demolition firing device. This device consists [illegible] 1-30) and a receiver (figure 1-31). The firing device [illegible] antenna coiled inside within the carrying handle. The [illegible] at distances up to 3.2 kilometers (2 miles) over land, 5 kilometers (3 miles) over water, and 10 kilometers [illegible]

Figure 1-30. M[illegible]

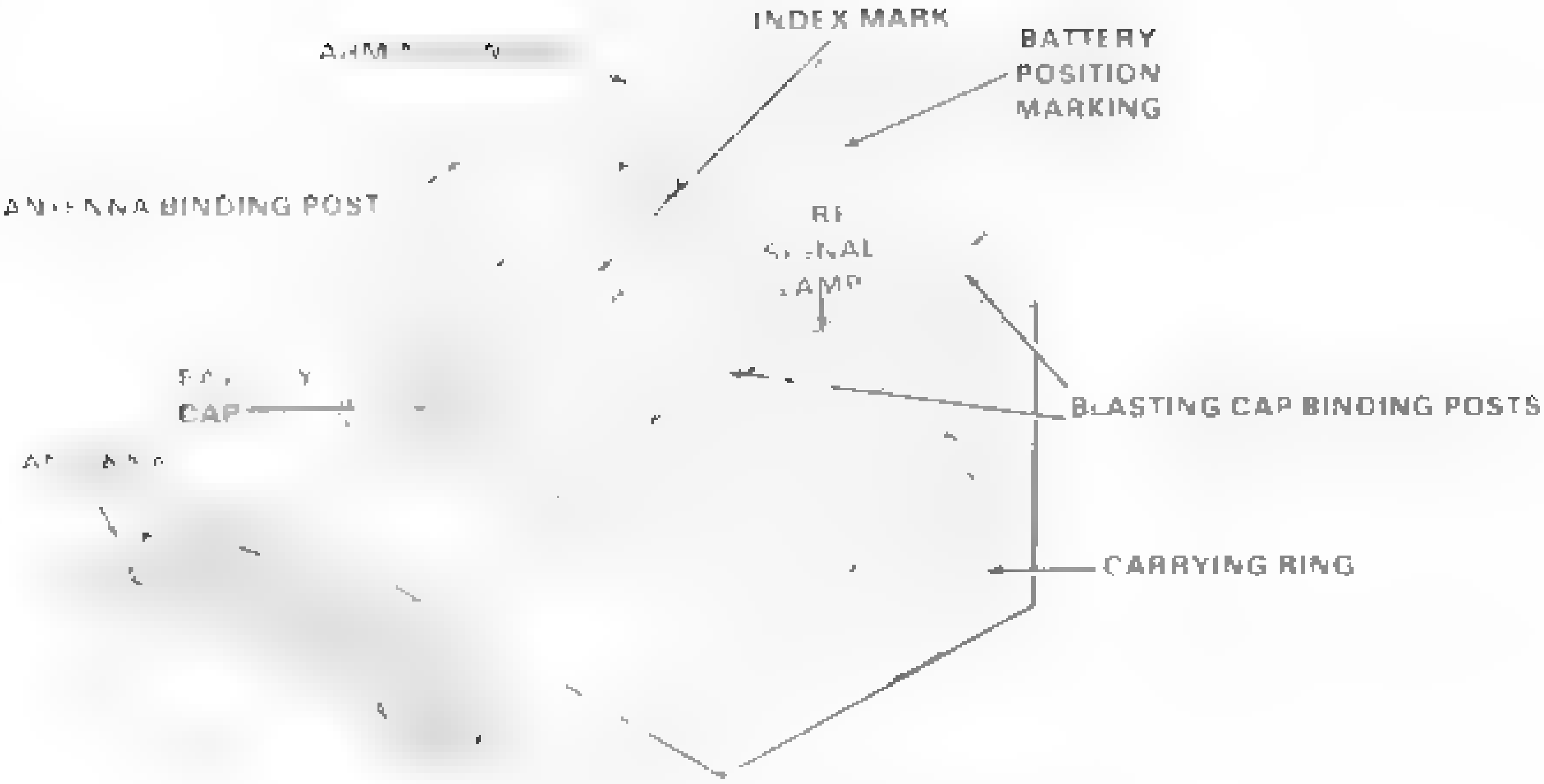


Figure 1-31. M122 demolition firing device receiver

Firing Wire and Reels

Types of firing wire. Wire for firing electric charges is issued in 500-foot coils. The two-conductor AWG No 18 is a plastic-covered or rubber-covered wire. It is carried on the reel unit RL39A described in the following paragraph. The single-conductor AWG No 20 annunciator wire is issued in 200-foot coils and used for making connections between blasting caps and firing wire. The WD-1 TT communication wire can also be used, but it has a higher resistance which increases the power requirement, so that blasting [illegible] of caps with this wire. As a rule of thumb, use 10 caps less than the machine rating for each 1,000 feet of WD-1 wire.

Reels. There are three types of reels applicable for military demolition usage: RL39A, a 500-foot reel with detachable handles, and a 1,000-foot reel with detachable handles.

The RL39A is a reel with a spool that accommodates 500 feet of wire, a handle assembly, a crank, an axle, and two carrying straps (Figure 1-32). The fixed end of the wire is extended from the spool through a hole in the side of the drum

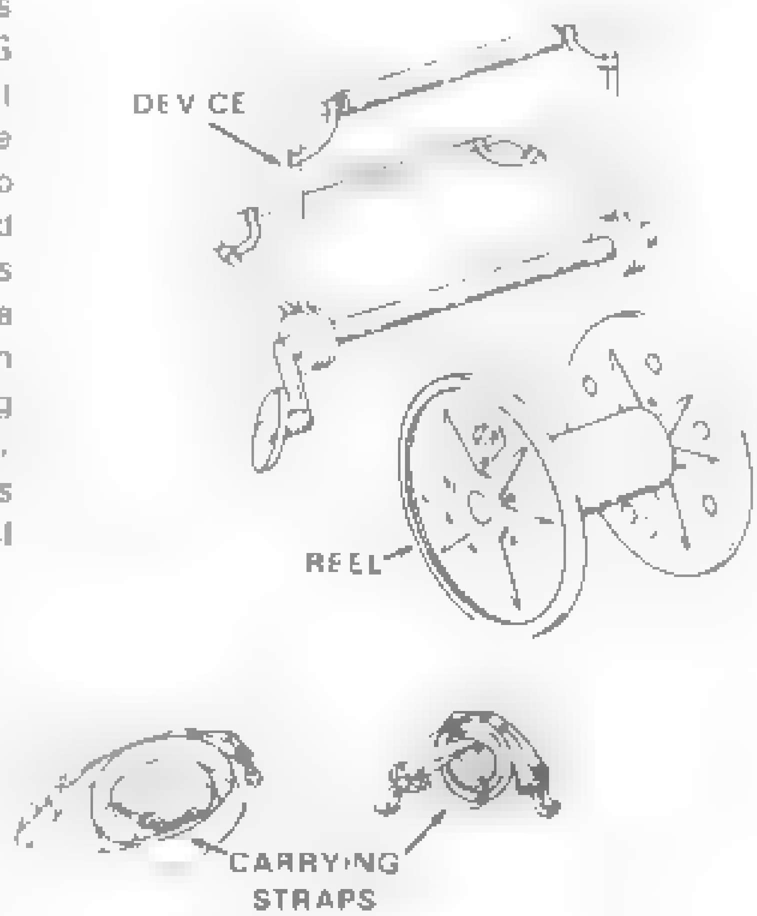


Figure 1-32. Firing wire reel

and fastened to two brass thumb out terminals. The carrying handles are made of two U-shaped steel rods. A loop at each end encircles a bearing assembly, which is a brass housing with a steel center to accommodate the axle. The crank is riveted to one end of the axle, and a cotter pin is placed in the hole at the other end to hold the axle in place.

A 500-foot reel with detachable handles is a metal drum mounted on an axle to which two detachable D-shaped handles are fastened. Use the arm with the knob on the side of the drum for cranking (Figure 1-33).

The 1,000-foot reel is similar to the 500-foot reel except that it has a capacity of 1,000 feet of firing wire.

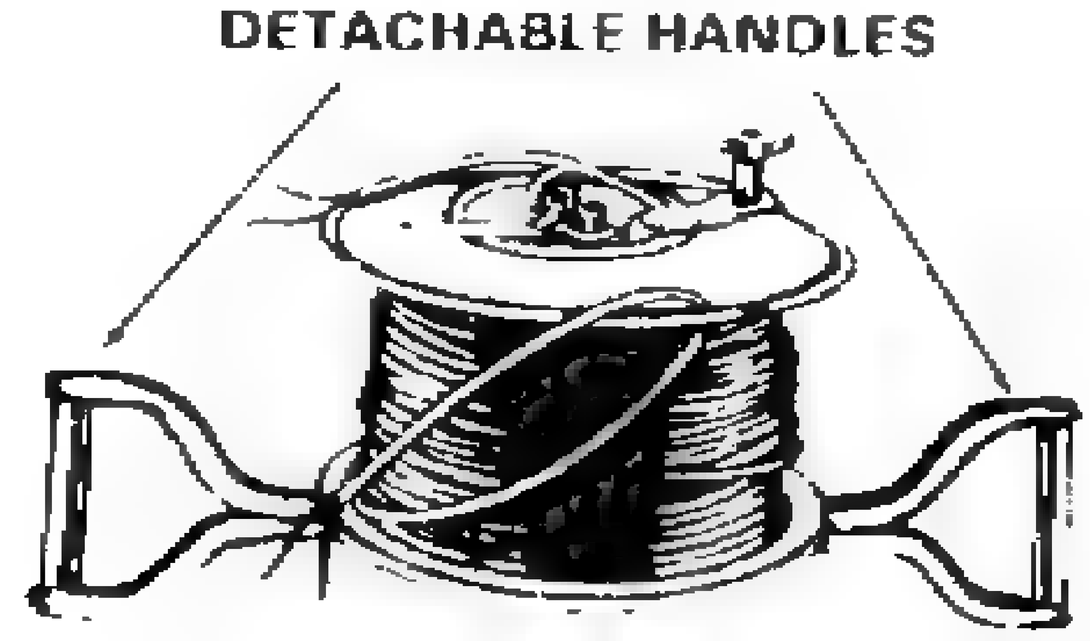


Figure 1-33. Reel with detachable handles

Detonating Cord Clip

The M1 detonating cord clip is a device that is used to hold together two strands of detonating cord either parallel or at right angles to each other (Figure 1-34). Connections are made more quickly with these clips than with knots. If left in place any length of time, knots may loosen and fail to function properly.

Connect branch line. Connect branch lines of a detonating cord by clipping the branch line with the U-shaped trough of the clip, and the main line with the tongue of the clip, as shown in Figure 1-34.

Splice detonating cord. Splice the ends of a detonating cord by overlapping them approximately 12 inches, using two clips, one at each end of the overlap, and bending the tongues of the clips firmly over both strands. As shown in Figure 1-34, the connection is made secure by bending the trough end of the clip back over the tongue.

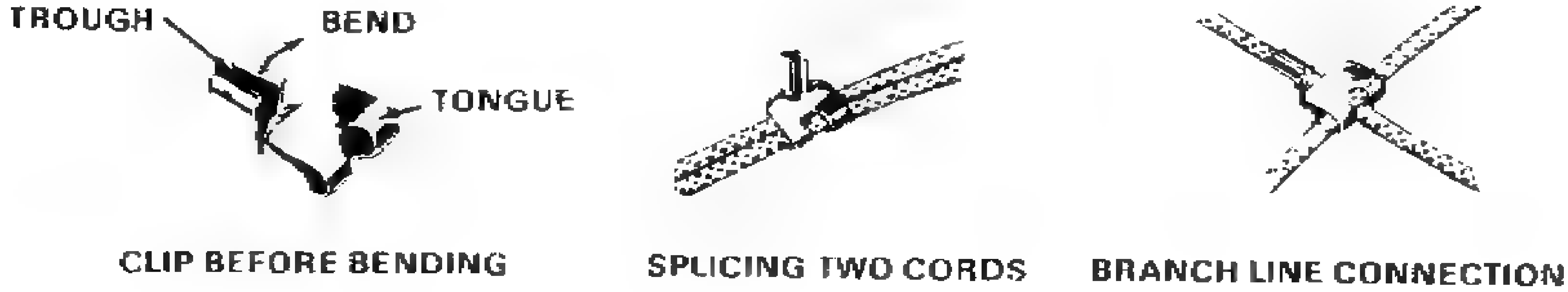


Figure 1-34. M1 detonating cord clip

Firing Devices and Other Accessory Equipment

M10 universal explosive destructor. The M10 destructor is a high explosive charge in an assembled metal device. It is initiated by blasting caps or mine activators with standard firing devices. The chief function of the destructor is the conversion of loaded projectiles and bombs to improvised demolition charges and the destruction of abandoned ammunition (Figure 1-35). For a detailed description, see TM 43-0001-38.

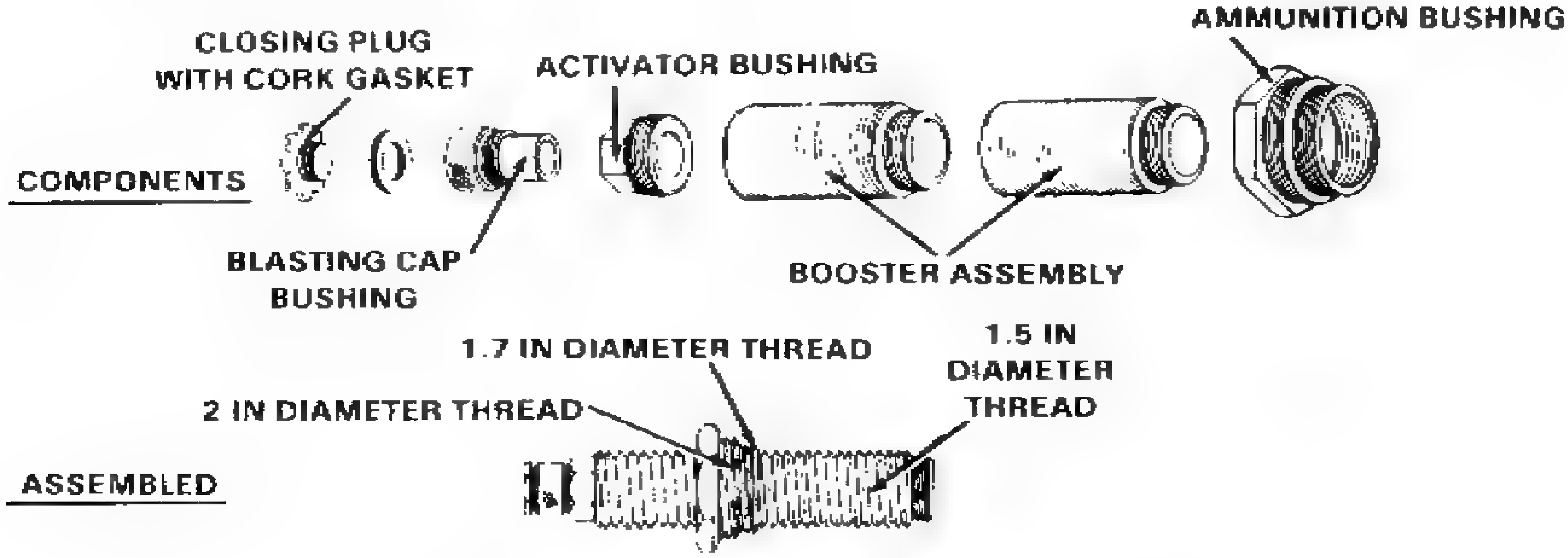


Figure 1-35. M10 universal explosive destructor

M19 explosive destructor. The M19 explosive destructor consists of an explosive-filled cylindrical body with a removable tip assembly which may be discarded if it is not needed (Figure 1-36). This destructor can be primed with a delay detonator, delay firing device with a high-output blasting cap, a nonelectric high output blasting cap initiated by time blasting fuse or detonating cord, or an electric high-output blasting cap. The cap well on each end is threaded to receive the standard base coupling or a priming adapter. This device is particularly suitable for use as a dust initiator, described in Appendix C, and for similar charges.

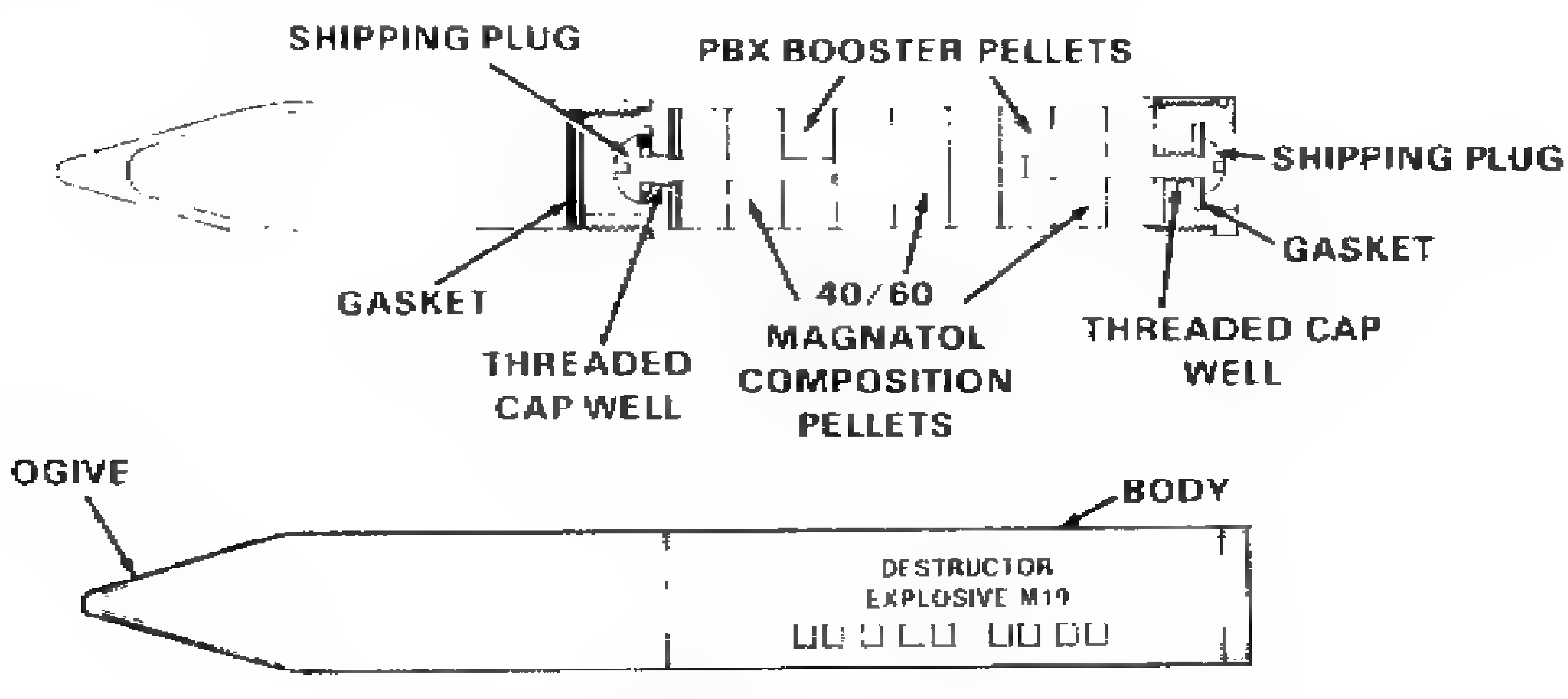


Figure 1-36 M19 explosive destructor

M1 concussion detonator. The M1 concussion detonator is a mechanical firing device actuated by the concussion wave of a nearby blast (Figure 1-37). It fires several charges simultaneously without connecting them with wire or detonating cord. A single charge fired in water or air will detonate all charges primed with concussion detonators within range of the main charge or of each other (Table 1-7).

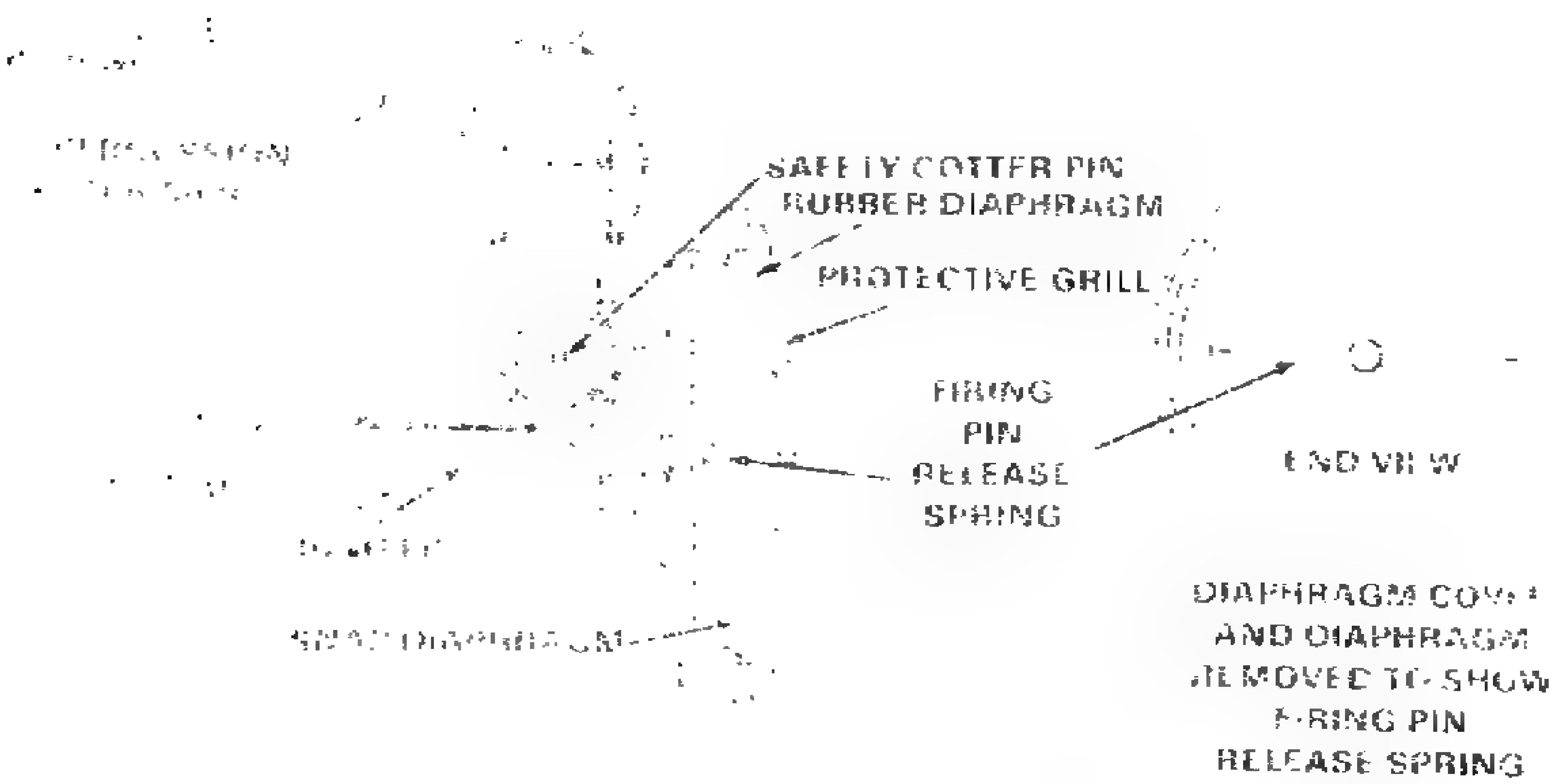


Figure 1-37. M1 concussion detonator

[illegible] Detonation range of concussion detonators

[illegible]	In water		In air	
	Depth of water, ft	Recommended range, ft	Recommended range, ft p 99%	Recommended range, ft p 99.9%
		1[illegible]		
	[illegible]	50		
	[illegible]	80		
		[illegible]		
			12.5	10.8
	[illegible]	[illegible]		
		8[illegible]		
	[illegible]	9[illegible]		
	[illegible]	[illegible]		
			14.1	11.5
			18.8	15.[illegible]
			21.5	18.0
			25.2	21.2
		[illegible]		
	[illegible]	[illegible]		
	[illegible]	180		
	[illegible]	20[illegible]		

[illegible] detonating charge

The detonator base is threaded to fit all standard cap wells in demolition blocks and explosive devices. While detonators often work at ranges greater than those in Table 1-7, their reliability is not ensured. For safety reasons, this detonator should not be used in surf at depths greater than 15 feet. That is because it will function by hydrostatic pressure at a depth of 25 feet. Further, if the salt delay pellet is crumbled from long storage, the detonator should not be used on underwater charges. For details of function and use, see TM 43-0001-38.

M1A2 15-second delay percussion detonator. This detonator consists of a firing pin assembly joined to a delay housing and primer holding assembly (Figure 1-38). To install the percussion detonator, remove the cap protector and screw the device into the threaded cap well of the demolition block or explosive device.

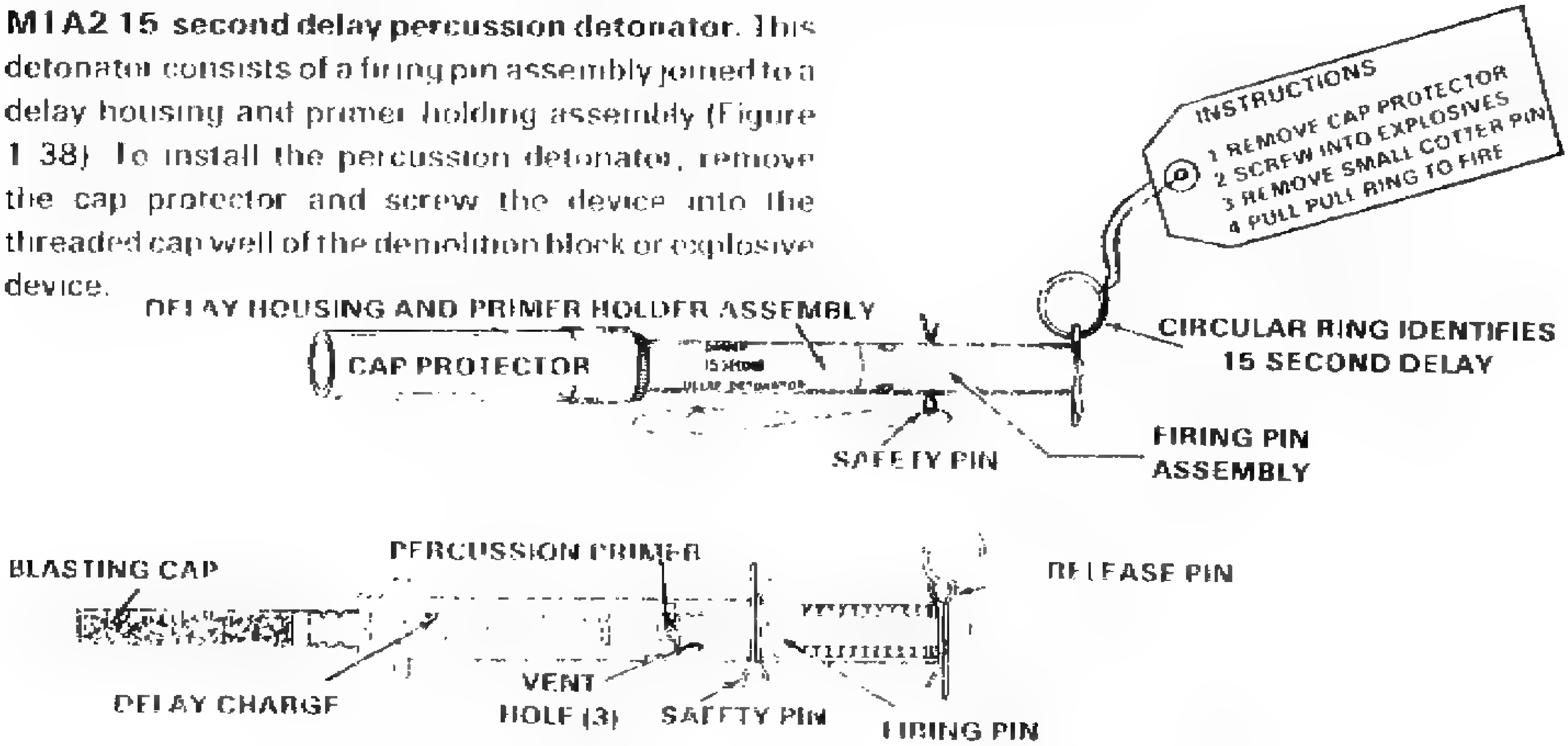


Figure 1-38. M1A2 15-second delay percussion detonator

M2A1 8-second delay percussion detonator. With the exception of the 8-second delay period, the marking, and the shape of the pull ring, the M2A1 delay (shown in Figure 1-39) is the same as the M1A2 15-second delay percussion detonator.

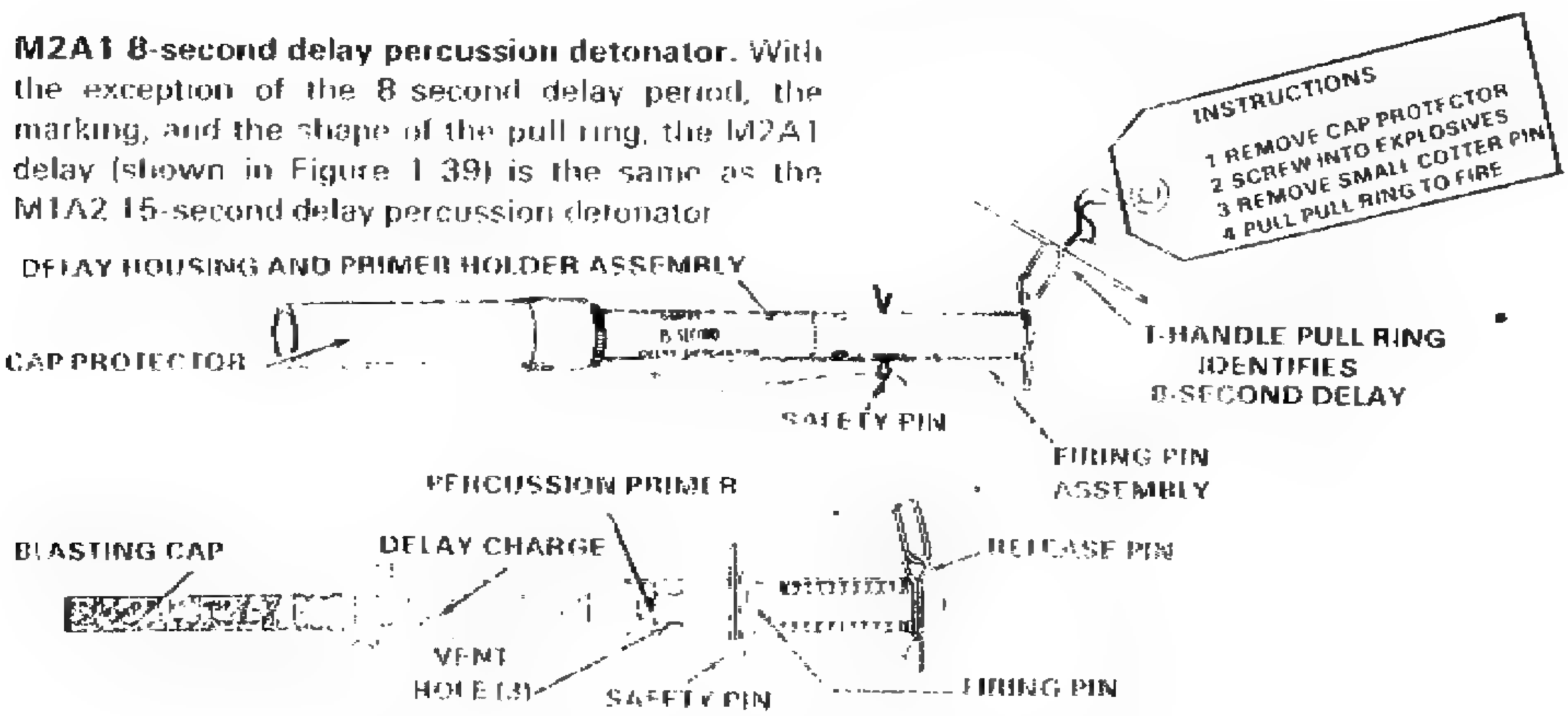


Figure 1-39. M2A1 8-second delay percussion detonator

M1 delay firing device. The M1 delay firing device is shown in Figure 1-40, and its characteristics are given in Table 1-8. The proper steps of installation include the following:

- Select a device with the proper time delay (Table 1-9).
- Insert a nail in the inspection hole to make sure that the firing pin has not been released. If the firing pin has been released, the nail cannot be pushed through the device.
- Remove the protective cap from the base.
- With crimper, attach a nonelectric blasting cap to the base. Crimper jaws should be placed no further than ¼ inch from the open ends of the blasting cap.
- Secure a firing device in the demolition charge or explosive device.
- Crush glass ampoule between thumb and fingers.
- Remove safety strip.

WARNING

If the safety strip cannot be removed easily, do not force it. Remove and discard device without removing safety strip since the firing pin may have released or could be released by the handling required to remove a jammed strip.

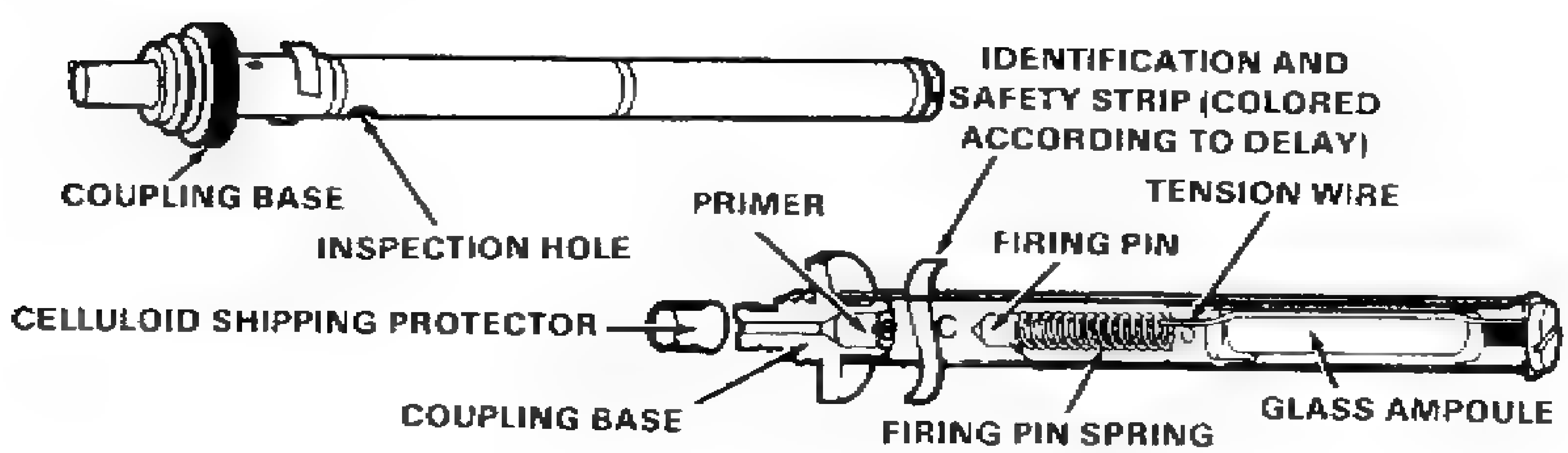


Figure 1-40. M1 delay firing device

Table 1-8. Characteristics of the M1 delay firing device

Case	Color	Dimensions, in Diameter	Dimensions, in Length	Internal action	Delay
Copper and brass	Natural metal	7/16	6¼	Mechanical with corrosive chemical release	1 min to 23 days, identified by color of safety strip

Safety	Packaging
Colored metal strip inserted in slot above percussion cap	10 units—2 red, 3 white, 3 green, 1 yellow, and 1 blue and a time delay table packed in paperboard carton, 10 cartons in fiberboard box, and 5 boxes in wooden box

Table 1-9. Time delay related to temperature for the M1 delay firing devices

Temp (°F)	Black		Red		White		Green		Yellow		Blue		Temp (°C)
	*OM	**ST	OM	ST	OM	ST	OM	ST	OM	ST	OM	ST	
-25			8.5 hr	3.3 min	3 da	1.3 da							-32
0	6 hr	2.5 hr	45 min	20 min	17.5 hr	8 hr	2.6 da	1.2 da	8.5 da	3.8 da	23 da	10 da	18
+25	36 min	16 min	25 min	11 min	5.5 hr	2.5 hr	17 hr	8 hr	2.0 hr	20 hr	5.0 da	2.2 da	- 4
50	15 min	7 min	17 min	8 min	2 hr	55 min	6 hr	2.7 hr	14 da	6.0 hr	1.3 da	14 hr	+10
75	9 min	4 min	15 min	7 min	1 hr	27 min	2.5 hr	70 min	5.5 hr	2.5 hr	11.5 hr	5 hr	24
100	5 min	2 min	8 min	3.5 min	32 min	14 min	70 min	30 min	2.5 hr	65 min	5.2 hr	2.3 hr	38
125	4 min	1.5 min	5 min	2 min	20 min	9 min	35 min	15 min	80 min	46 min	2.5 hr	1.1 hr	52
150	3 min	1 min	4 min	1.5 min	15 min	6 min	20 min	9 min	46 min	72 min	80 min	36 min	66

**Note.* OM—Most likely delay if two devices are used in the same charge. If only a single device is used, this value should be increased approximately 15 percent.

***Note.* ST—Reasonable safe time. Delays of less than this value should not occur more than one in a thousand.

M60 weatherproof fuze igniter. This device is designed to ignite a time blasting fuse in all sorts of weather conditions, even underwater if properly waterproofed. The fuse is inserted through a sealing rubber grommet and into a split collet which secures the fuse when the end cap on the igniter is tightened (Figure 1-41). A pull on the pull ring releases the striker assembly, allowing the firing pin to drive against the primer, which ignites the fuse.

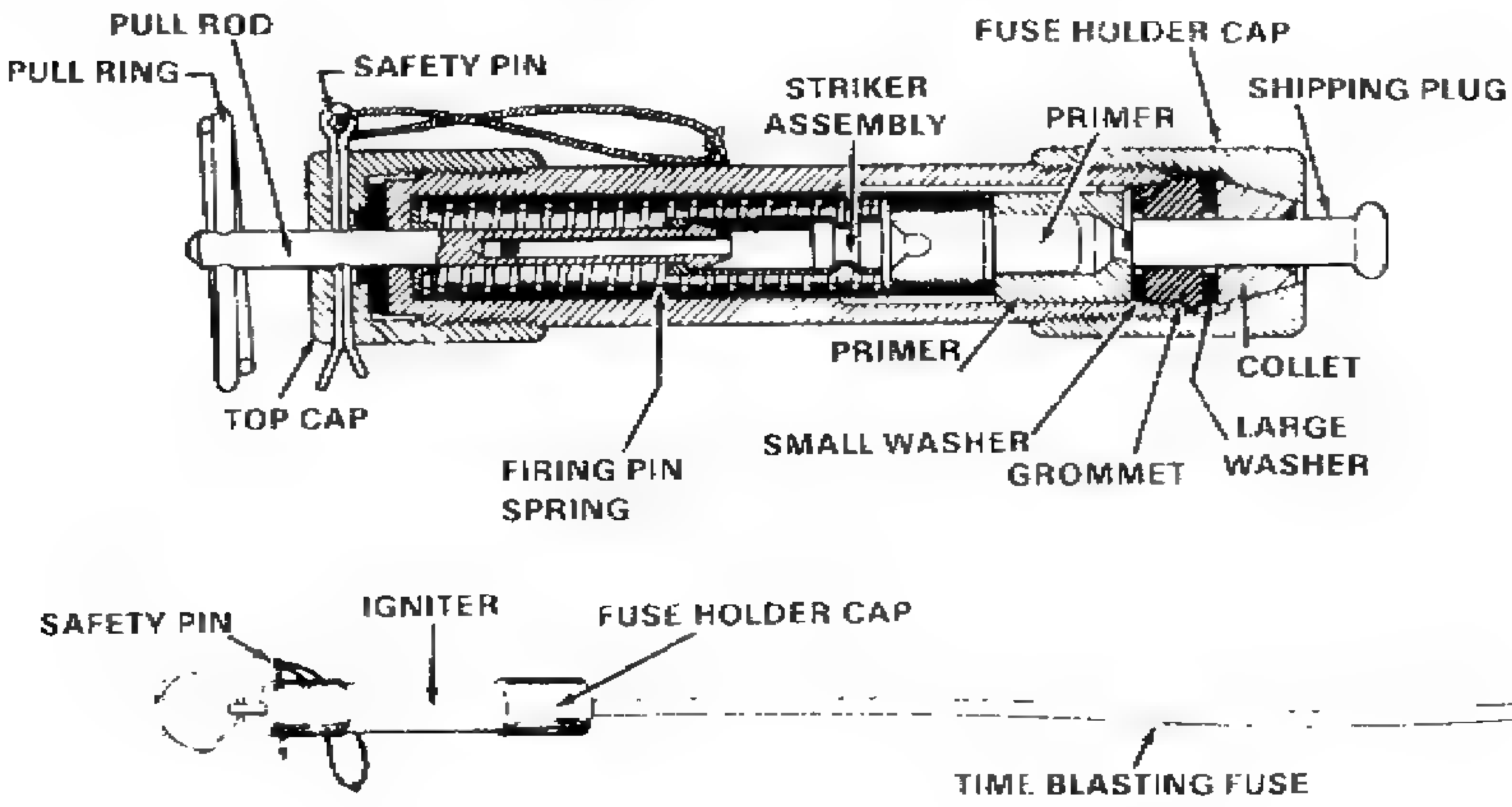


Figure 1-41. M60 fuze igniter

Demolition card. This pocket-sized card (Graphic Training Aid (GTA) 5-10-28) tabulates data for the timber-cutting, steel-cutting, breaching, and cratering charges.

Additional tools. Tools such as posthole augers, posthole diggers, earth augers, and pneumatic tools will help to facilitate the placement of charges.

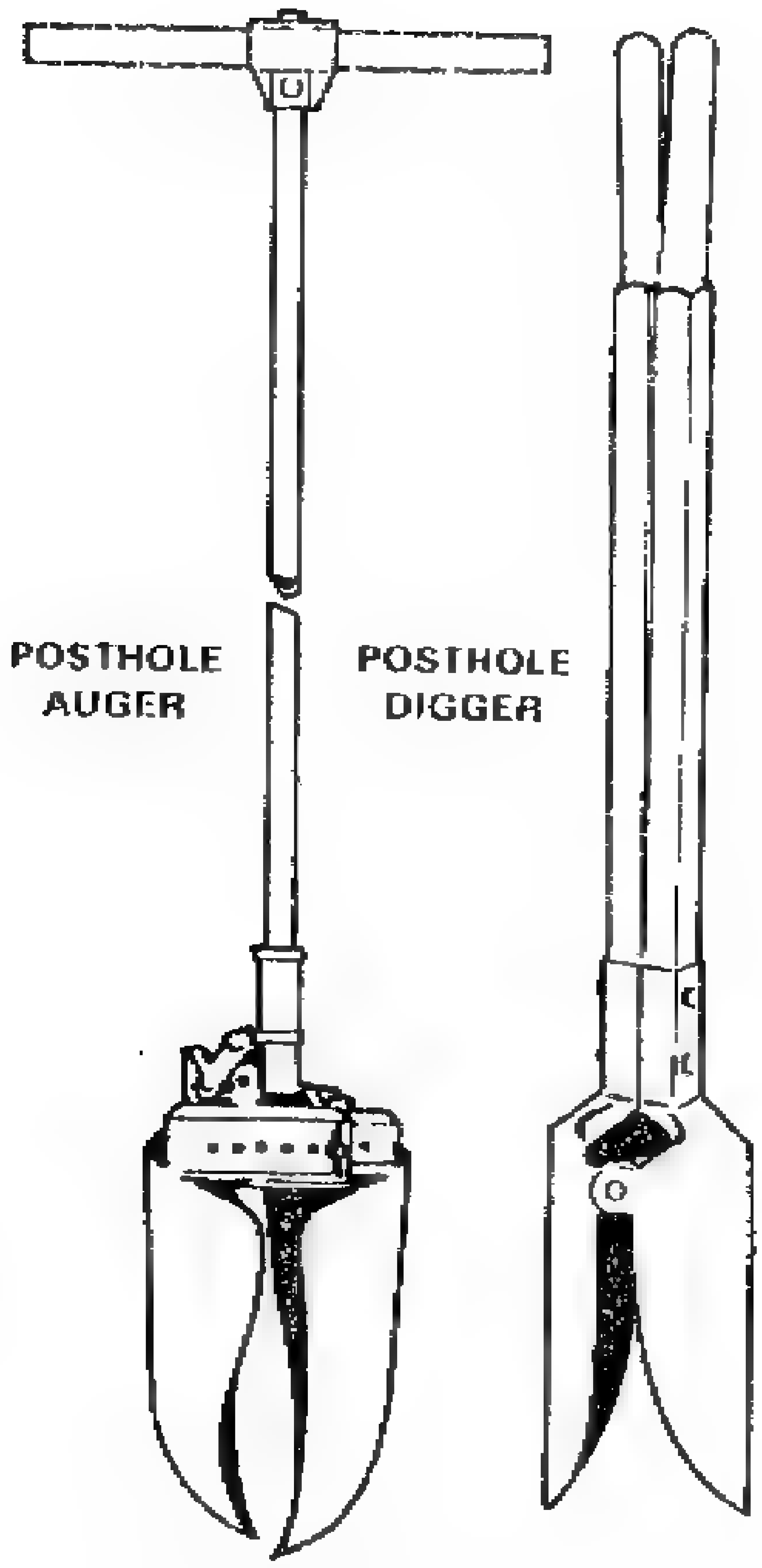


Figure 1-42. Hand-operated digging tools

The 10-inch hand operated posthole auger is capable of boring a hole large enough for the 40-pound ammonium nitrate cratering charge and other charges of equal size (Figure 1-42). The extension handle permits boring as deep as 8 feet.

The posthole digger has two concave metal blades on hinged wooden handles (Figure 1-42). The blades are forced into the earth, and soil is removed by pulling the handles apart and lifting it out of the hole.

The motorized earth augers drill holes 8, 12, 16, or 20 inches in diameter to depths up to 8 feet.

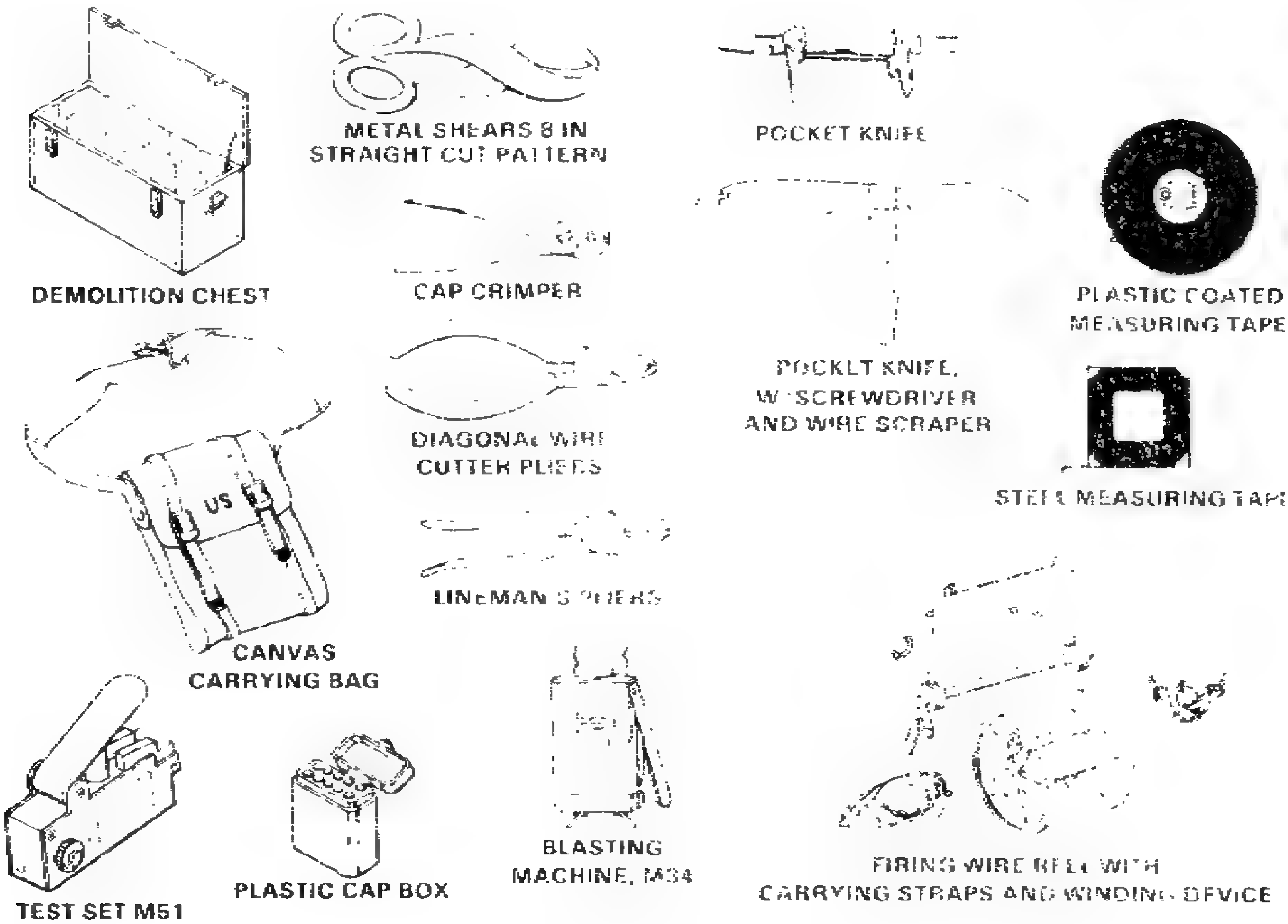
Pneumatic tools are rock drills, pavement breakers, and wood-boring machines. For the placement of internal charges, the rock drill bores up to 2 inches in diameter in rock, concrete, or masonry. The pavement breaker is used to shatter the hard surface of roads before drilling boreholes with an auger for cratering charges. The wood-boring machine drills boreholes in wood for the placement of internal charges.

Demolition Equipment Set

This set, termed electric and nonelectric explosive initiating demolition equipment set, is an assembly of items needed to initiate and carry out almost all demolition projects (Figure 1-43).

M123E1 165-mm Cartridge

The combat engineer vehicle (CEV) mounts a 165-millimeter gun which fires a high explosive plastic (HEP) cartridge. This cartridge contains approximately 60 pounds of Composition A3. It is primarily used for breaching obstacles and destroying fortified positions. For additional details on usage, see FM 5-1.



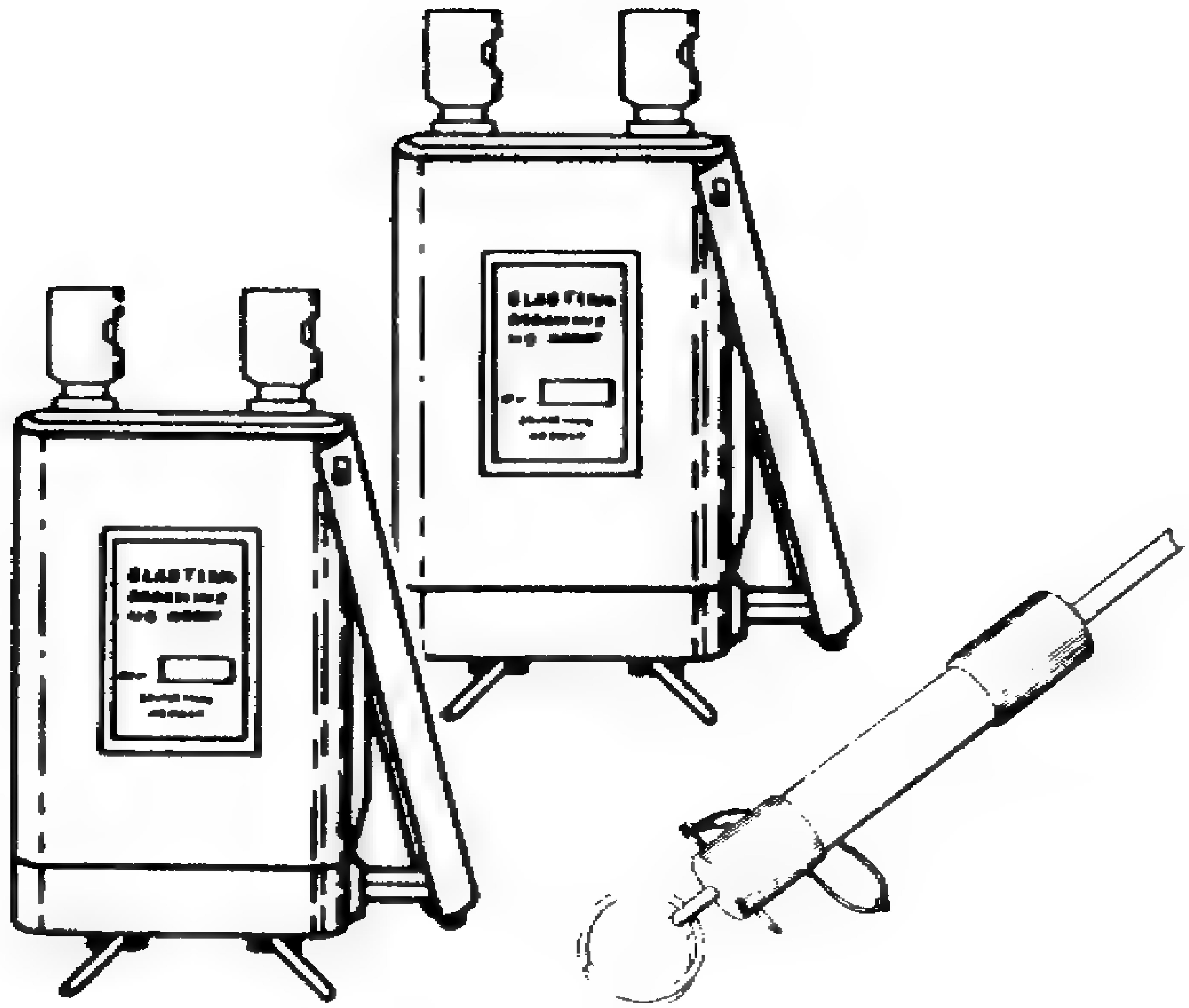
ITEMS SHOWN NOT TO SCALE

NOTE: The basic set consists of the listed items. They may be requisitioned seperately

NONEXPLOSIVE ITEMS.		EXPLOSIVE ITEMS.	
Quantity	**Item**	**Quantity**	**Item**
3	BAG, DEMOLITION EQUIPMENT	1	BLASTING MACHINE, M34
5	BOX, BLASTING CAP plastic, 10 cap capacity	2	PLIERS, LINEMAN'S with side cutter, 8 inch length
1	CHEST, DEMOLITION engineer platoon, [illegible]	1	PLIERS, DIAGONAL CUTTING, 6 inch length
4	CRIMPER, BLASTING CAP M2	4	REEL, CABLE
2	KNIFE, POCKET special tools, can opener, punch	1	REELING MACHINE, CABLE, HAND
2	KNIFE, POCKET screwdriver and wire scraper	1	TEST SET, BLASTING CAP, M51
1	SHEARS, METAL CUTTING, HAND straight pattern, 8 inch		
2	TAPE, MEASURING steel, millimeters and inches		
1	TAPE, MEASURING plastic coated, 100 feet		

Figure 1-43. Electric and nonelectric explosive initiating demolition equipment set

firing systems 2



This chapter discusses the two types of systems for firing explosives—nonelectric and electric—that are in general use. Both have their individual priming methods and materials. In addition, detonating cord may be used with both systems to make them more efficient and effective.

NONELECTRIC FIRING SYSTEMS

Components and Assembly for Detonation

A nonelectric system is one in which an explosive charge is prepared for detonation by means of a nonelectric blasting cap. The basic priming materials consist of a nonelectric blasting cap, which provides a shock adequate to detonate the explosive, and the time blasting fuse, which transmits the flame that fires the blasting cap (Figure 2-1). If more than one charge must be detonated simultaneously, the nonelectric system must be combined with the detonating cord to ensure simultaneous firing (see Chapter 2, Detonating Cord Firing Systems). The assembly of a basic nonelectric system follows.

Figure 2-1. Nonelectric initiation system

Checking time blasting fuse. Using an M2 crimper, cut and discard a 6-inch length from the free end of the time blasting fuse to prevent a misfire caused by the exposed powder absorbing moisture from the air (Figure 2-2). Cut off a 3-foot length of time blasting fuse to check the burning rate. Ignite the fuse with a fuze lighter, if available. If a fuze lighter is not available, split the end of the fuse. Insert a match head into the split end, and light the match with another match, or rub the abrasive against it (Figure 2-3). Note the time it takes for the fuse to burn. Compute the burning rate per foot by dividing the time in seconds by the length in feet.

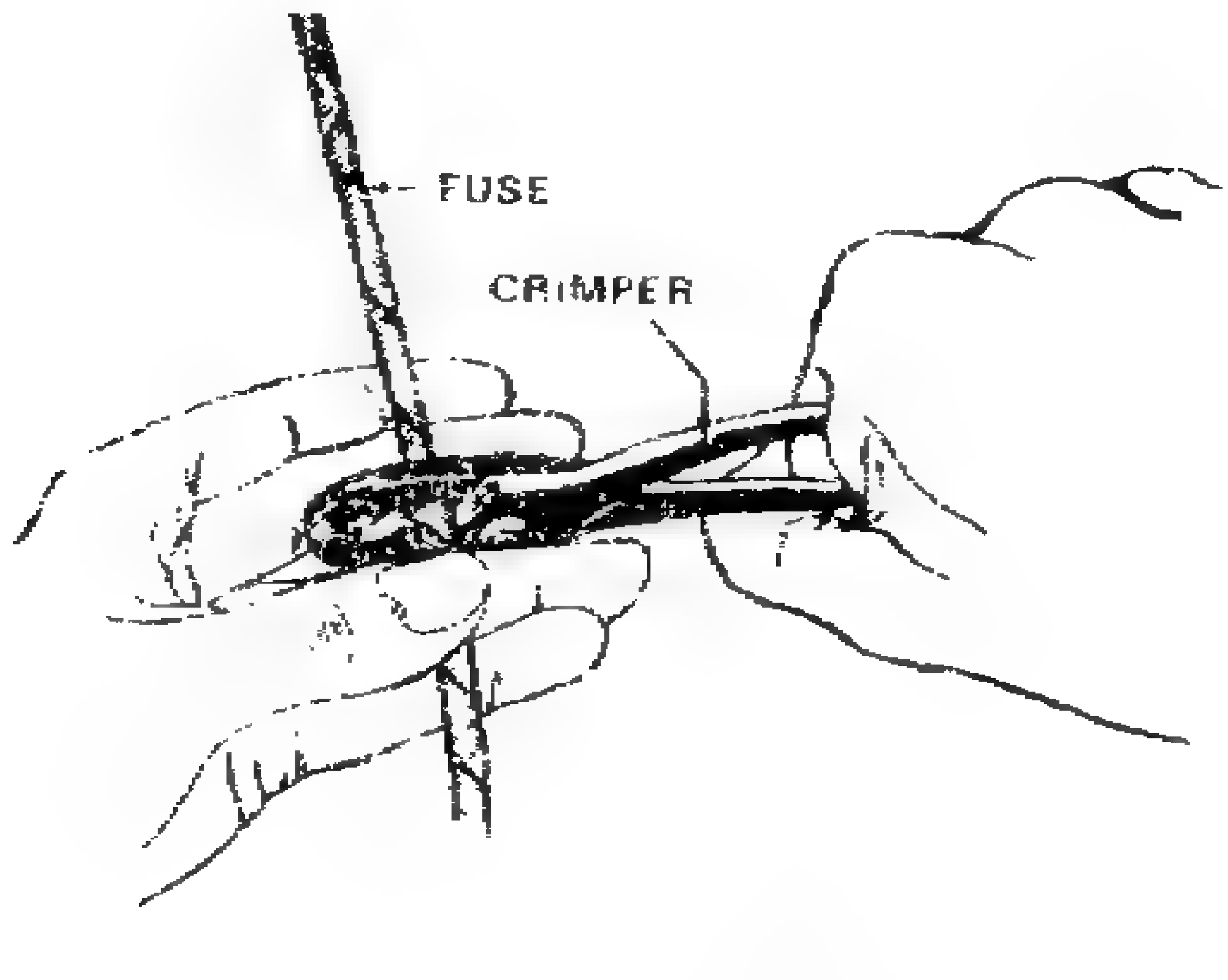


Figure 2-2. Cutting the fuse

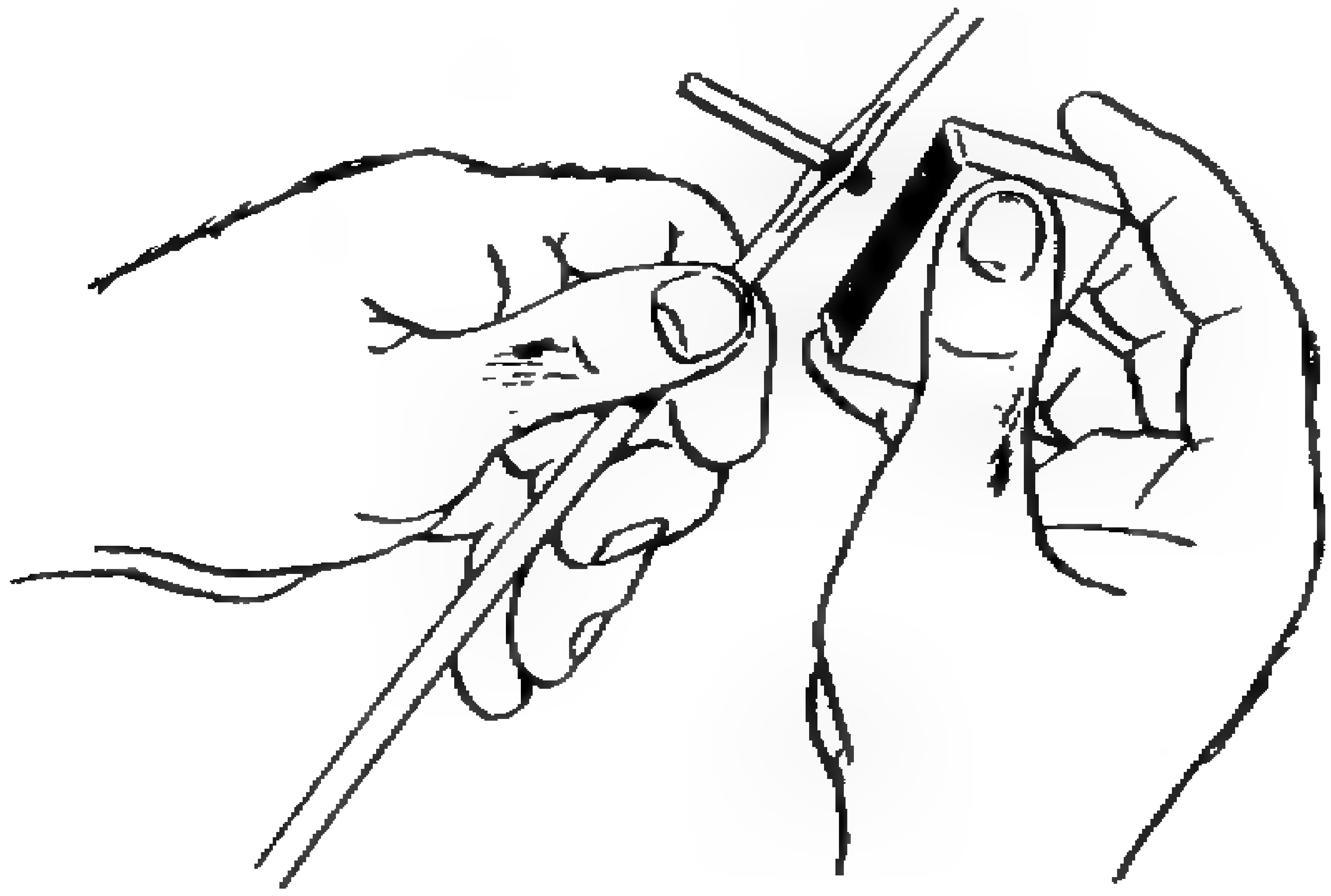


Figure 2-3 Lighting time blasting fuse with match

Preparing time fuse. Cut the time blasting fuse long enough to permit the person detonating the charge to reach a safe distance by walking at a normal pace before the explosion. Make this cut squarely across the time fuse

WARNING

A rough, jagged-cut fuse inserted into a blasting cap can cause a misfire. If a serviceable M2 crimper is not available, use a sharp knife to cut the fuse. To ensure that the fuse is cut square when using the knife, cut the fuse against a solid surface such as wood.

Preparing blasting cap. Take one blasting cap from the cap box. Inspect the blasting cap by looking into the open end. If any foreign matter or dirt is present, use the following procedure:

- Hold the cap, near the open end, between the thumb and middle finger of one hand.
- Aim the open end of the cap at the palm of the second hand.
- Gently bump the wrist of the cap-holding hand against the wrist of the other hand.
- If the foreign matter does not come out, dispose of the cap in accordance with local regulations.

Placing blasting cap. Hold the time blasting fuse vertically with the square-cut end up, and slip the blasting cap gently down over it so that the flash charge in the cap is in contact with the time fuse. If the cap is not in contact, it may misfire. Never force the time fuse into the blasting cap by twisting or any other method. If the end is flat or too large to enter the blasting cap freely, roll the time fuse between the thumb and fingers until the size is reduced to permit free entry.

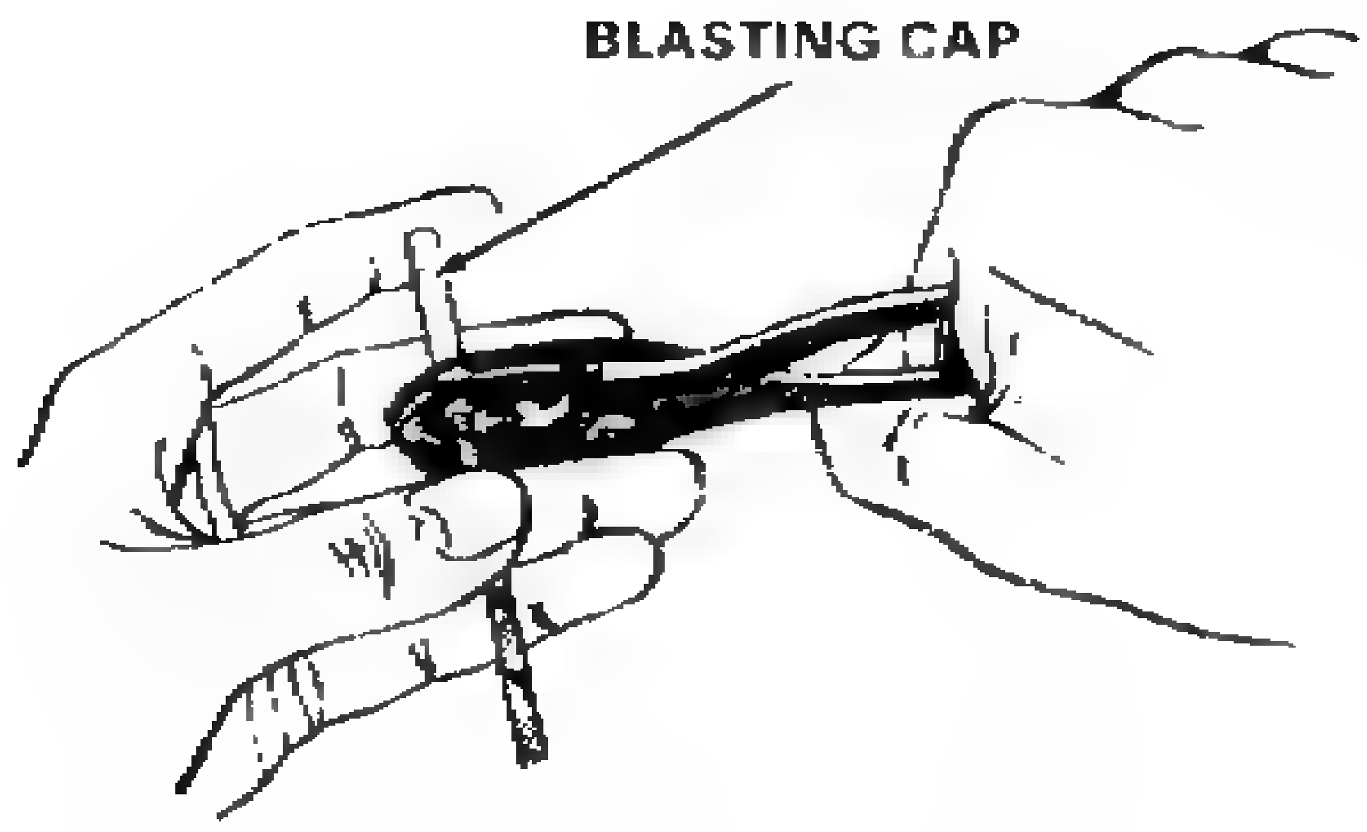
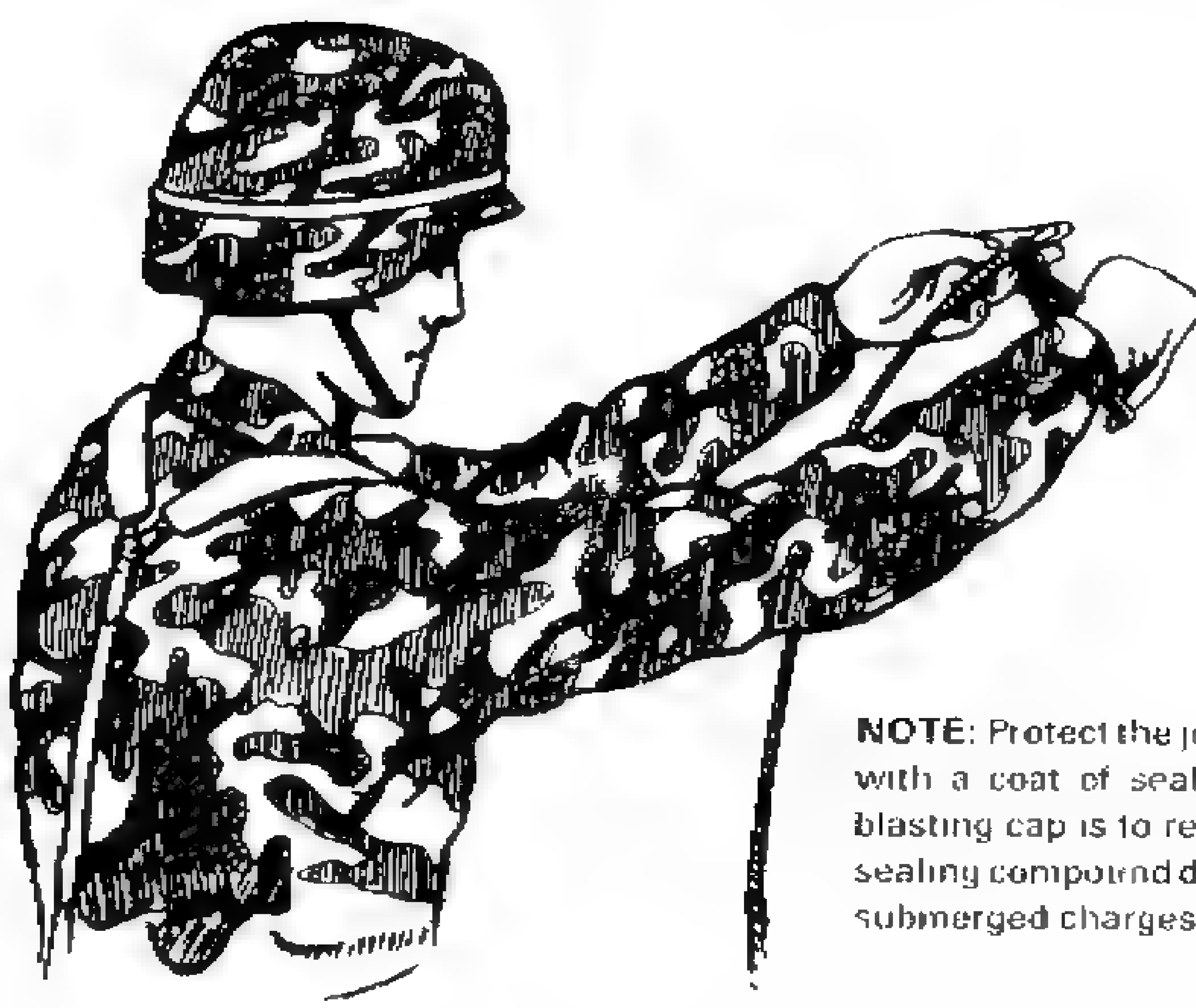


Figure 2-4. Crimping on the cap

Handling blasting cap. After the blasting cap has been seated, grasp the time blasting fuse between the thumb and third finger of one hand so that the fingers are touching the open end of the cap. Place the forefinger over the closed end of the cap to hold it firmly against the end of the time fuse. Apply slight pressure on the closed end of the cap with the forefinger (Figure 2-4).

Placing crimpers. Rest the crimpers on top of the thumb and ring finger of the other hand. Place the second finger on top of the crimpers to secure them (Figure 2-4). Accurate crimping can be achieved even in darkness because a finger can be used to locate the open end of the blasting cap.

Crimping cap. Crimp the blasting cap at a point $\frac{1}{8}$ to $\frac{1}{4}$ of an inch from the open end. A crimp too close to the explosive in the blasting cap may cause detonation. Point the cap out and away from the body during crimping (Figure 2-5)



NOTE: Protect the joint between the cap and the time blasting fuse with a coat of sealing compound or a similar substance if the blasting cap is to remain in place several days before firing. This sealing compound does not make a waterproof seal, therefore, fire submerged charges immediately

Figure 2-5. Proper position for crimping the blasting cap

Attaching cap assembly to explosives. Pass the end of the time blasting fuse through the priming adapter. The time fuse should move through the adapter. Pull the cap into the adapter until it stops. Insert the cap into the cap well of the

explosive, and screw the adapter into place. If a priming adapter is not available, insert the blasting cap into the cap well and tie it in place with a string, or fasten it with adhesive tape or other available material. Details of preparing blocks for nonelectric priming are given in Chapter 2, Priming of Demolition Blocks.

NOTE: For blasting with long lengths of time fuse, it may be more convenient to pass the end of the fuse through the priming adapter before crimping the cap onto the time fuse.

Attaching fuze igniter to time fuse. To attach M60 weatherproof fuze igniter, unscrew the fuse holder cap two or three turns but do not remove. Press the shipping plug into the igniter to release the split collet (Figure 1-41 on page 1-45), rotate the plug top, and remove it from the igniter.

Insert the free end of the time fuse as far as possible in the space left by removing the shipping plug. Then tighten the cap sufficiently to hold the fuse in place and weatherproof the joint.

To fire, hold the barrel in your free hand, and remove the safety pin. Grasp the pull ring, push it in, and rotate to ensure that the igniter is set. In the event of a misfire, the M60 can be reset quickly without disassembly by pushing the plunger all the way in and attempting to fire as before. (It cannot be reset underwater because water can enter the interior of the nylon case through the holes in the pull rod. The fuze igniter is reusable if the primer is replaced.)

NOTE: Under some circumstances, attach the M60 fuze igniter to the time fuse in advance to save time or to avoid exposing components to rain. The M60 can be attached to the time fuse with the cap prior to inserting the cap in the explosive, providing the safety pin is not removed until the time of ignition.

Lighting time blasting fuse by an alternate means. If a fuze igniter is not available, light the time blasting fuse with a match. Split the fuse at the end (Figure 2-3 on page 2-3) and place the head of an unlighted match in the powder train. Light the inserted match head with a flaming match, or rub the abrasive on the match box against it.

Nonelectric Misfires

Preventing nonelectric misfires. Working on or near a misfire is the most hazardous blasting operation. A misfire should be rare if the following procedures are carefully observed:

- Prepare all primers properly.
- Load charges carefully.
- Place the primer properly.
- Perform any tamping operation with care to avoid damage to the prepared charges.
- Fire the charge according to the proper technique.
- Use dual firing systems, if possible (see Chapter 2, Dual Firing Systems). If both systems are properly assembled, the possibility of a misfire is reduced.
- Do **not** use blasting caps underground. Use detonating cord.

Clearing nonelectric misfires. Occasionally, a nonelectric misfire will occur. [illegible]

- [illegible] time of detonation. This allows ample time for any explosion delayed because of a defective powder train in the fuse. Under certain combat conditions [illegible]
- If the misfired charge is not tamped, do not move or disturb it. Lay a primed 1-pound charge at the side of the misfired charge, and fire.
- [illegible] by placing and detonating a new 2-pound charge on top.
- [illegible] impractical, carefully remove the tamping with wooden or nonmetallic tools. [illegible] top of the charge will minimize the danger of striking the charge. When the charge has been uncovered within 1 foot, insert and detonate a new 2-pound [illegible] Cord Firing Systems).
- [illegible] to the same depth within 1 foot of the old one. Place a 2-pound primed charge [illegible] away to induce detonation.

ELECTRIC FIRING SYSTEMS

Components and Assembly for Detonation

An electric [illegible] TM 9-1375-213-34 [illegible]

WARNING Do not connect the blasting machine to [illegible] wire until prefiring tests are complete and the charge is ready for firing

[illegible] priming are given in Chapter 2 Priming Demolition Blocks

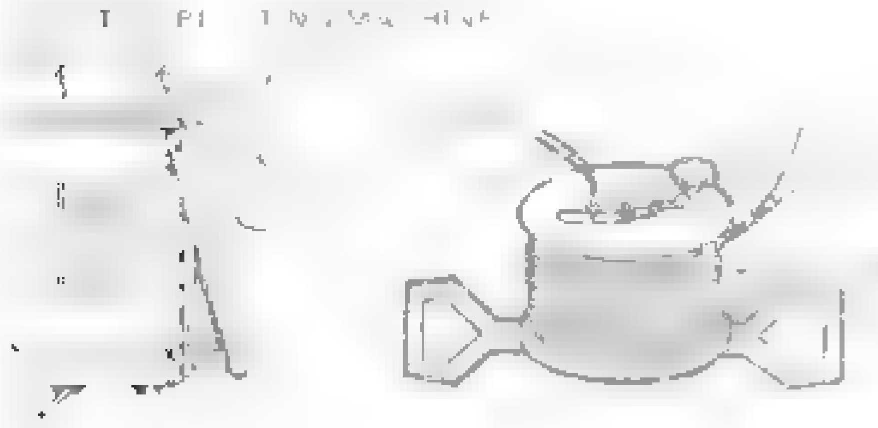


Figure 2 6 Electric initiation system

Table 2 1 Minimum safe distance from transmitter antennas

[illegible] W	[illegible]
0 3[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
5 000–20 000	[illegible]
20 000–50 000	[illegible]
[illegible]	[illegible]

[illegible]

Lay out firing wire. The following steps are used to lay out firing wire:

- After locating a firing position a safe distance away from the charges, lay out the firing wire from the charges to the firing position
- Test the firing wire as described in Chapter 2, Testing Electric Wires, Blasting Caps, and Circuits.
- Twist the free ends of the firing wire together to prevent an electric charge from building up in the firing wire.

Test blasting caps. The following steps are used to test blasting caps:

- Test each blasting cap to be used in the electric system as described in Chapter 2, Testing Electric Wires, Blasting Caps, and Circuits.
- After each cap has been tested, twist the free ends of the cap lead wire together or shunt them with the short-circuit shunt to prevent an electric charge from building up in the cap lead wires.

Connect series circuit. The following steps are used to connect series circuit:

- Connect the lead wires into one of the two series circuits (Chapter 2, Series Circuits), if two or more electric blasting caps are used.
- Test the blasting caps with the test set or galvanometer as described in Chapter 2, Testing Electric Wires, Blasting Caps, and Circuits, if more than two blasting caps are used in the series circuit or if the circuit is complicated.
- Splice the free cap lead wires to the firing wire.

Insert caps into charges. Place the blasting caps in the explosive charges and fasten the caps securely to the charges. For details of electric priming of demolition blocks, see Chapter 2, Priming Demolition Blocks.

Test entire circuit. The following steps are used to test the entire circuit:

- Move to the firing position and test the entire firing circuit with the test set or galvanometer as described in Chapter 2, Testing Electric Wires, Blasting Caps, and Circuits.
- Twist the free ends of the firing wire together.

Test blasting machine. Test operate the blasting machine several times as outlined in TM 9-1375-213-34 to ensure that it is working.

Connect blasting machine. The following steps are used to connect the blasting machine:

- Untwist the free ends of the firing wire and fasten them to the two posts of the blasting machine.
- Operate the blasting machine to fire the charges.

Observe precautions. A number of precautions should be observed. If two or more electric blasting caps are connected in the same circuit, be sure they are the same type and made by the same manufacturer. This is essential in preventing misfires. Blasting caps of different manufacturers have different electrical characteristics. These differences can result in some caps in the circuit not firing because other caps fire more quickly and break the circuit before the slower caps have received enough electricity to fire. This is not true, however, of the M6 special electric blasting caps, all of which are made according to the same specifications. Identify blasting caps of the same manufacturer by the label, color of the cap, or shape of the shunt.

For safety reasons, only one soldier should be detailed to connect the blasting machine to the firing circuit, and the same soldier should fire the circuit. This soldier should be responsible for the care and security of the blasting machine at all times during blasting activities.

Splicing Electric Wires

Strip the insulating material from the end of insulated wires before splicing. Expose approximately 3 inches of bare wire, as shown in Figure 2-7, and remove any foreign matter, such as enamel, by carefully scraping the wire with the back of a knife blade or another suitable tool. Do not nick, cut, or weaken the wires when the wires are bare. Twist multiple strand wires lightly after scraping.

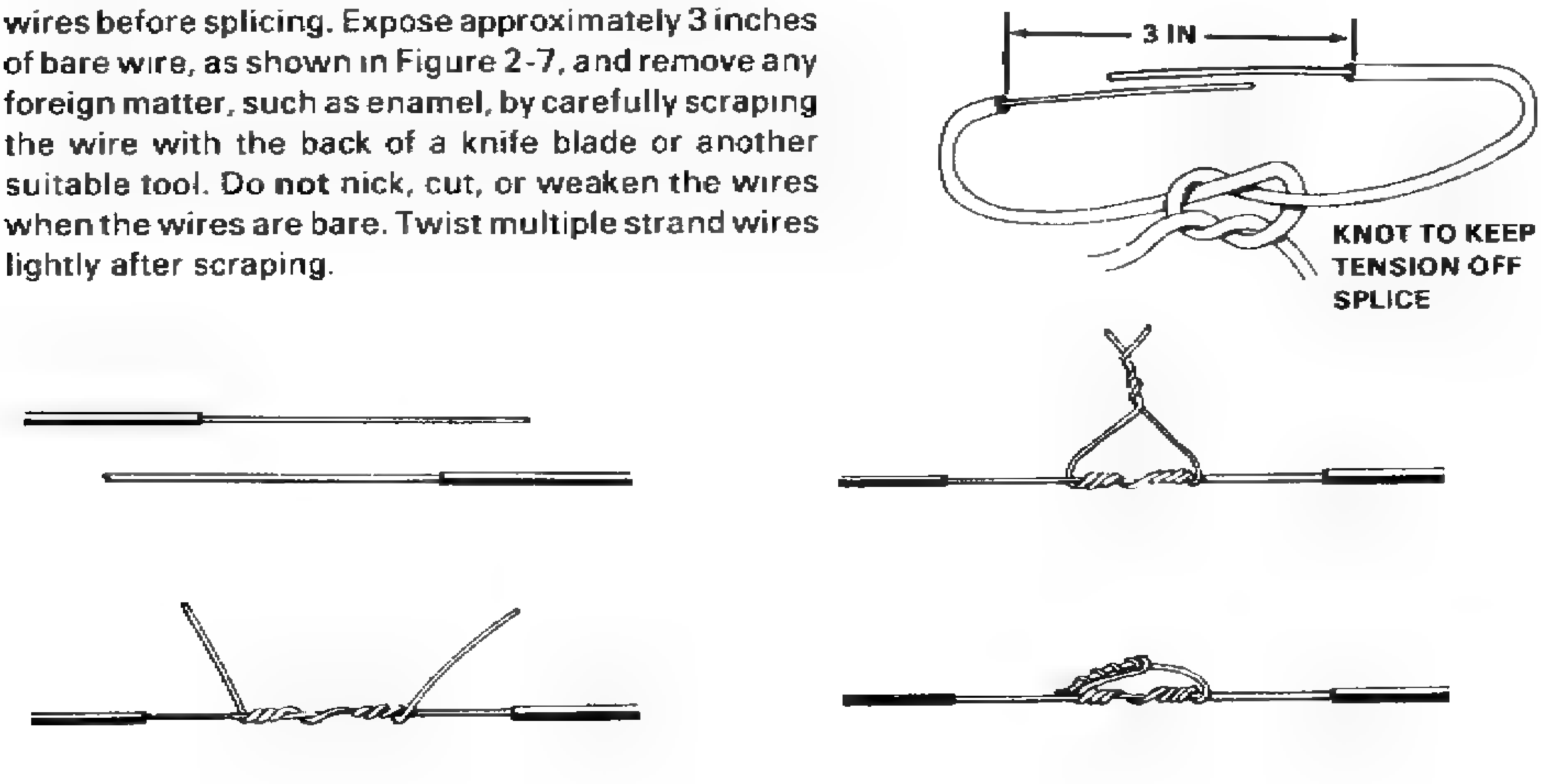


Figure 2-7. Western Union pigtail splices

Splicing method. Two wires, prepared as described, may be spliced as shown in Figure 2-7. This is called the Western Union pigtail splice. Protect the splices from pull damage by tying the ends in an overhand or square knot, allowing sufficient length for each splice as shown. Splice two pairs of wires in the same

way as the two-wire splice (Figure 2-8). Splice one wire of one pair to one wire of the other pair. Repeat the process for the other two wires.

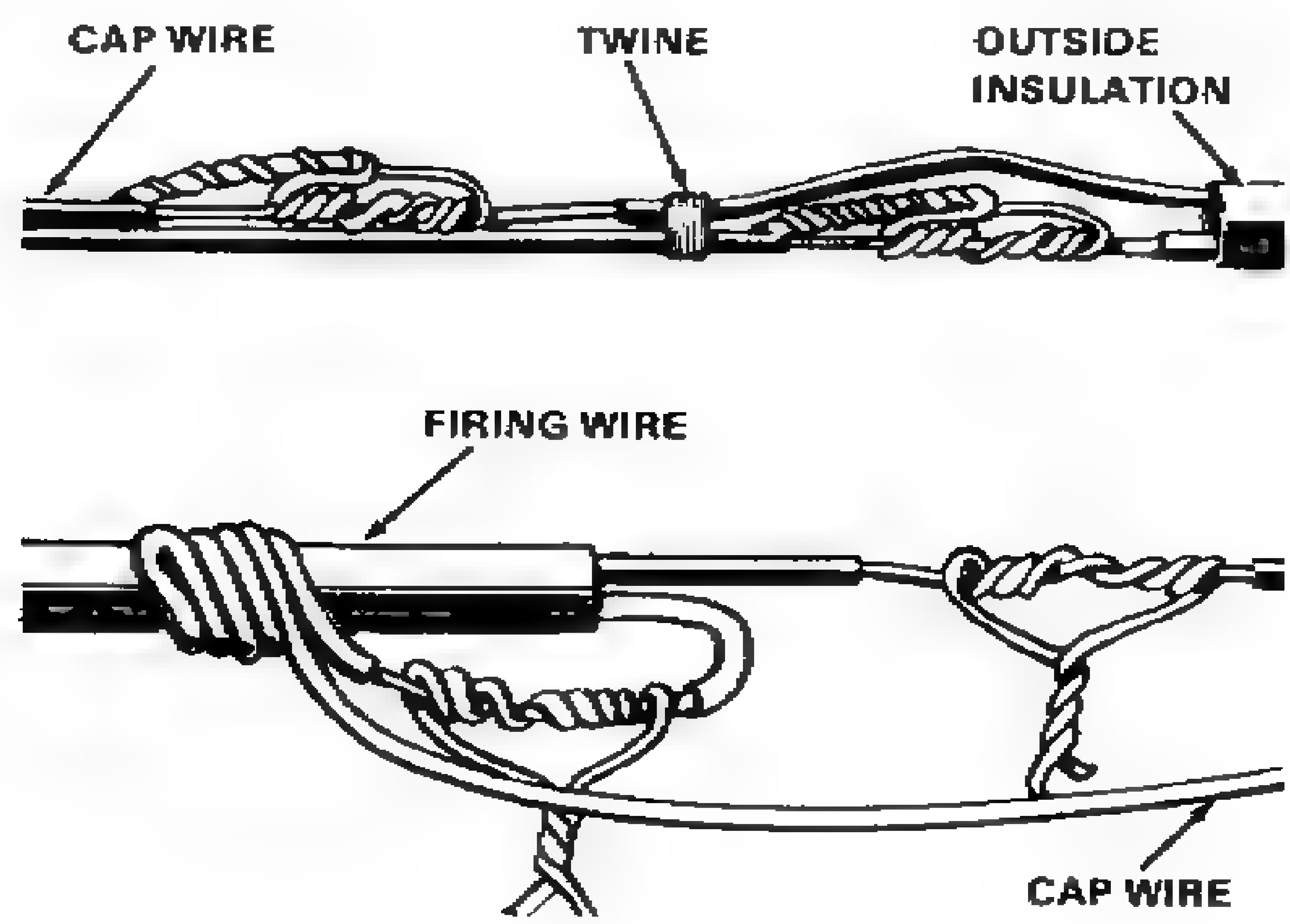


Figure 2-8. Splicing two pairs of wires

Splicing precautions. If certain precautions are not observed, a short circuit may easily occur at a splice. If the pairs of wires are spliced, stagger the two separate splices and tie them with twine or tape as in Figure 2-8. An alternate method of preventing a short circuit at the point of splice is shown in Figure 2-8. In the alternate method, the splices are separated, not staggered. Insulate splices from the ground or other conductors by wrapping them with friction tape or other electric insulating tape. This is particularly necessary when splices are placed under wet tamping. Circuit splices that are not taped or insulated should **not** lie on moist ground. Support the splices on rocks, blocks, or sticks so that only the insulated portions of the wires touch the ground. Protect the splices by inserting them in the cardboard cap spools which may be bent to hold the splice firmly inside.

Series Circuits

Common series. This circuit is used to connect two or more charges fired electrically by a single blasting machine (Figure 2-9, A). Prepare a common series circuit by connecting one blasting cap lead wire from the first charge to one lead wire in the second charge, and so on until only two end wires are free. Connect the free ends of the cap lead wires to the ends of the firing wire. Use connecting wires (usually annunciator wire) when the distance between blasting caps is greater than the length of the usual cap lead wires.

Leapfrog series. The leapfrog method of connecting caps in a series is useful for firing ditching charges or any long line of charges (Figure 2-9, B). This method consists of omitting alternate charges on the way and then connecting them to form a return path for the electric impulse to reach the other lead of the firing wire. This method eliminates laying a long return lead from the far end of the line of charges back to the firing wire. Additional information on series circuits is located in Appendix D.

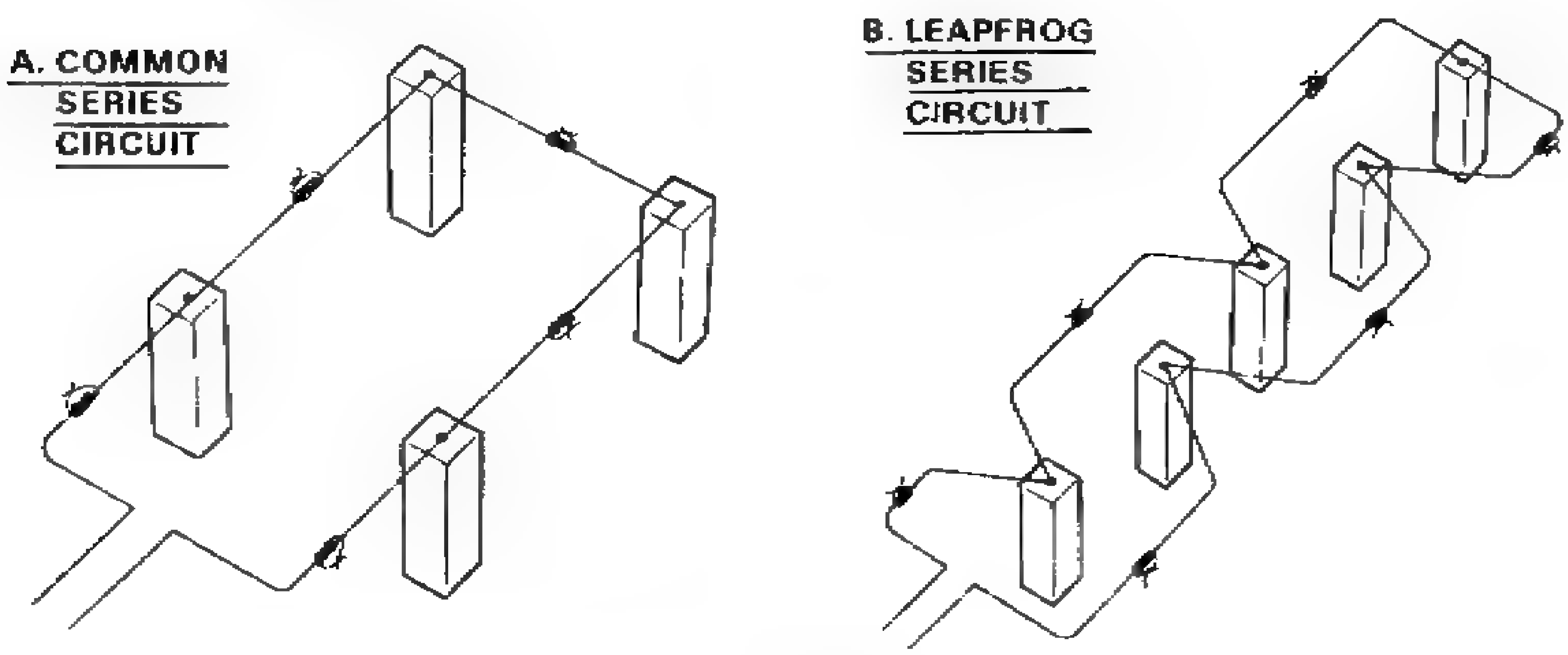


Figure 2-9. Series circuit

Testing Electric Wires, Blasting Caps, and Circuits

Testing firing wire. Firing wire may be tested as follows:

When using an M51 blasting cap test set—

- Check the test set by connecting the posts with a piece of bare wire or the legs of the M2 crimpers as shown in Figure 2-10. The indicator lamp should flash when the handle is squeezed.

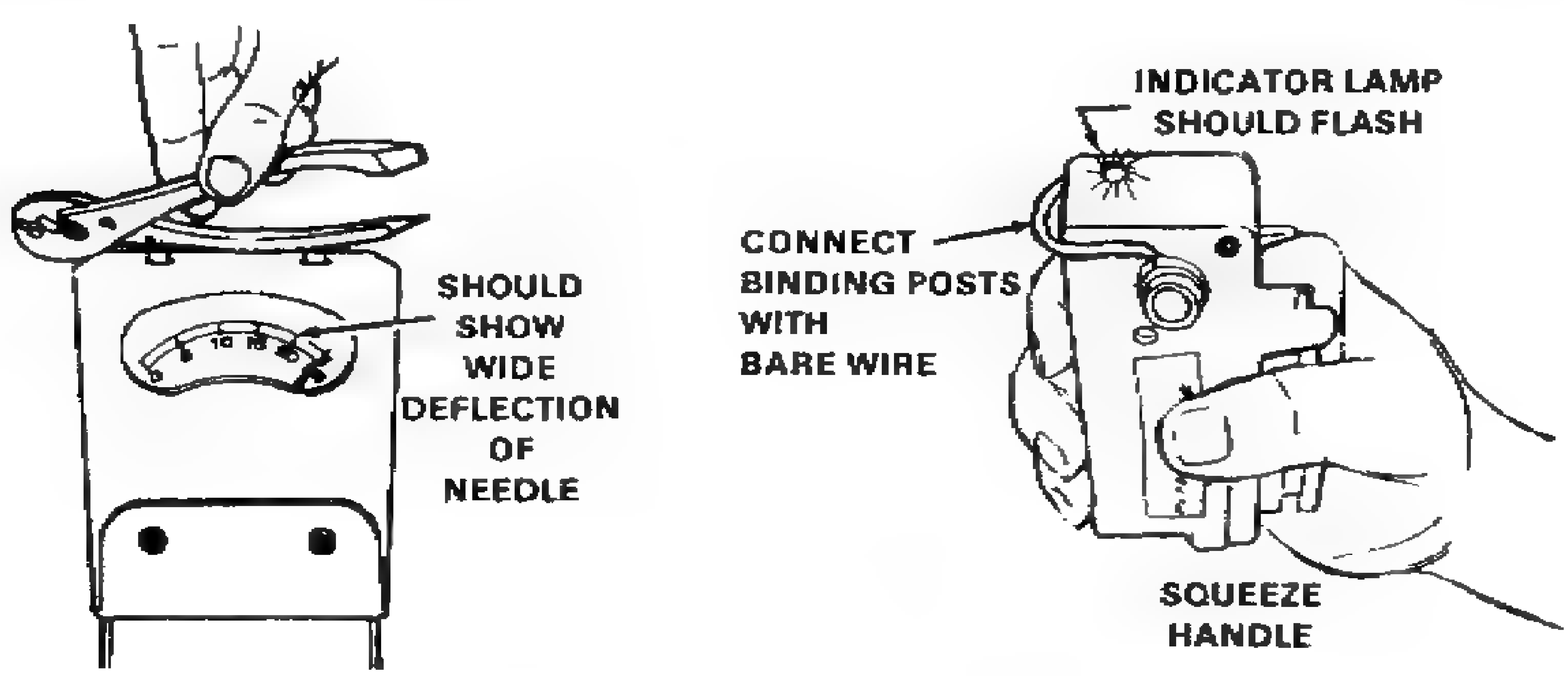


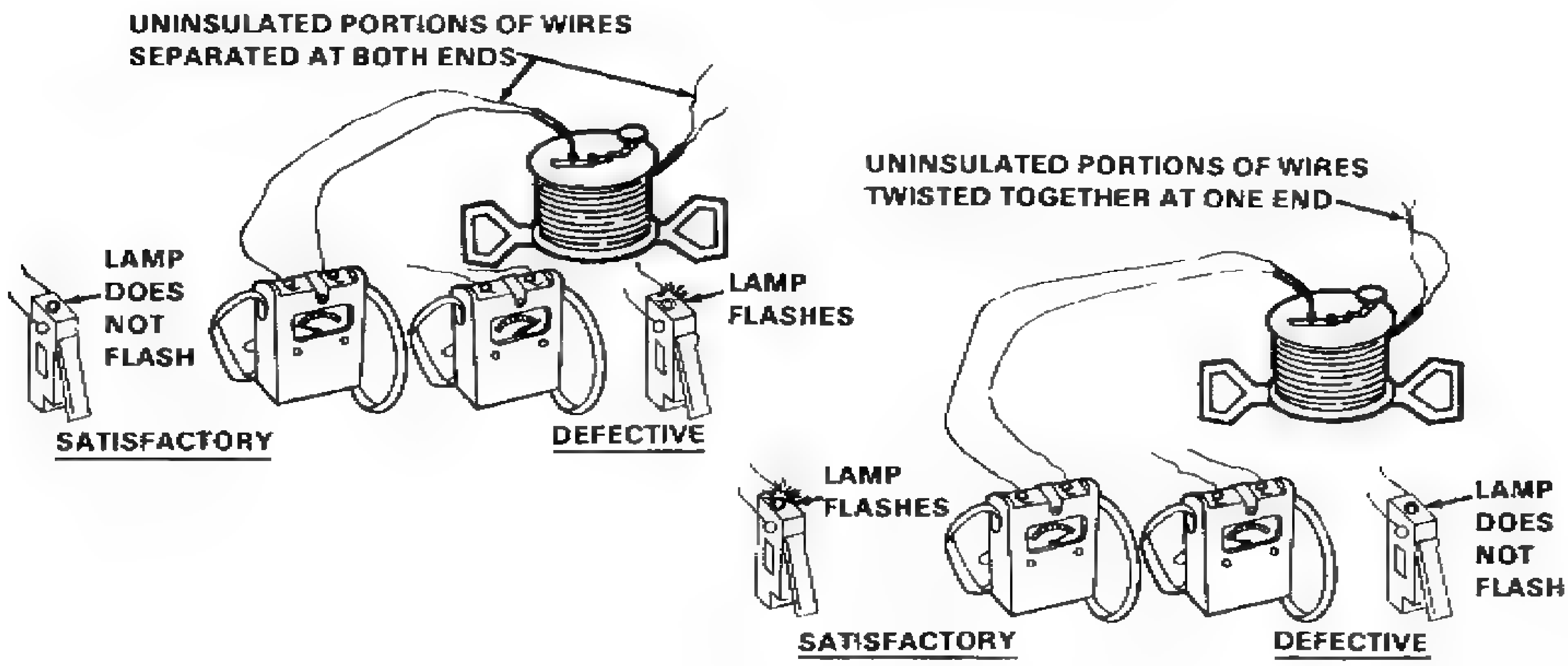
Figure 2-10. Testing the galvanometer or test set

When using the blasting galvanometer—

- Check the galvanometer by holding a piece of metal across its terminals (Figure 2-10, page 2-11). If the battery is good, the needle will show a wide deflection, approximately 25 units (0 ohms).
- Separate the firing wire conductors at both ends, and connect those at one end to the test set binding posts. Actuate the test set. The indicator lamp should **not** flash. If it does, the firing wire has a short circuit (Figure 2-11).
- Twist the wires together at one end, and connect those at the other end to the M51 test set posts. Actuate the test set. The indicator lamp should flash. If it does not flash, the firing wire has a break (figure 2-11).

When using the galvanometer—

- Separate the firing wire conductors at both ends, and touch those at one end to the galvanometer posts. The needle should **not** move. If the needle moves, the firing wire has a short circuit (Figure 2-11).
- Twist the wires together at one end, and touch those at the other end to the galvanometer posts. This should cause a wide deflection of the needle approximately 6½ ohms or 23 to 24 units for a 500-foot length. No movement of the needle indicates a break. A slight movement indicates a point of high resistance which may be caused by a dirty wire, loose wire connections, or wires with several strands broken off at connections.



NOTE: The firing wire may be tested on the reel, but it should be tested again after unreeling because this may separate broken wires not noticed when the wire was reeled

Figure 2-11. Testing firing wire

Testing electric blasting caps. Electric blasting caps may be tested as follows:

When using the M51 blasting cap test set—

- Check the test set as described.
- Remove the short-circuit shunt from the lead wires of the electric blasting cap. Place the blasting cap under a sandbag or like object to prevent injuries due to premature cap detonation during testing.
- Attach one cap lead wire to one binding post. Tie the other cap lead wire to the other post, and squeeze the test set handle. The blasting cap is satisfactory if the indicator lamp flashes. If it does **not** flash, the cap is defective and should **not** be used.

When using the blasting galvanometer—

- Check the galvanometer.
- Remove the short-circuit shunt and place the blasting cap under a sandbag or like object.
- Touch one cap lead wire to one galvanometer post and the other cap lead wire to the other post. If the galvanometer's needle deflects slightly less than it did when the instrument was tested, the blasting cap is satisfactory. If not, the cap is defective and should **not** be used. **Always** point the explosive end of the cap away from the body during the test.

NOTE: If the battery is fresh, the galvanometer should read 25 units (0 ohms) when the instrument is tested, and approximately 24 units (about 2 ohms) when a good blasting cap is tested.

Testing series circuit. Connect the free ends of the firing wire to the binding posts when using the blasting cap test set. The indicator lamp should flash. If the lamp does **not** flash, the circuit is defective.

NOTE: Since the M51 test set cannot discriminate between a firing circuit that is properly set up and one with a short circuit in it, special care must be taken in wiring the circuit to avoid shorting.

Touch the free ends of the firing wire to the galvanometer posts. This should cause a wide deflection of the needle. The extent of the deflection depends on the number of caps and the length of the firing wire. The circuit is defective if there is **no** deflection.

NOTE: To get a wide deflection of the needle, the galvanometer battery should be in good condition.

Shunt the wires if the firing circuit is defective. Go down range, and recheck the circuit repeating the steps in Chapter 2, Testing Electric Wires, Blasting Caps, and Circuits. Replace the wires if a splice is defective. Continue to test all caps and wires in the circuit. Test the entire circuit again to make sure that all breaks have been located before attempting to fire the charge.

Electric Misfires

Prevention of electric misfires. To help prevent misfires, make one individual responsible for all the electrical wiring in a demolition circuit. The same individual should do all the splicing and ensure that the following steps are carried out:

- Include all blasting caps in the firing circuit.
- Make all connections between blasting cap wires, connecting wires, and firing wires.
- Avoid short circuits.
- Avoid grounds.
- Make sure that the number of blasting caps in any circuit does not exceed the rated capacity of the power source on hand.

Causes of electric misfires. Common causes of electric misfires include inoperable or weak blasting machine or power source; improperly operated blasting machine or power source; defective and damaged connections causing either a short circuit, a break in the circuit, or high resistance with a resulting low current; or a faulty blasting cap. Other typical causes are use of blasting caps (other than M6) made by different manufacturers in the same circuit or use of more blasting caps than the power source rating permits.

Procedure for clearing electric misfires. Electric misfires must be cleared with extreme caution because of the hazards of burning charges and delayed explosions. Clear misfires of charges primed with detonating cord, and fired by an electric blasting cap, as described in Chapter 2, Detonating Cord Misfires. If the charge is electrically primed **above ground** and it is **not dual primed**, take corrective action immediately. If the misfire is **dual primed** and **above ground**, wait 30 minutes before approaching the misfire because a burning charge can cause the second cap to detonate the charge. If the charge is **dual primed** electrically with caps **below ground**, wait 30 minutes before investigating to make sure that the charge is not burning. If the system is **below ground** but **not dual primed** and a misfire occurs, proceed as follows:

- Check the firing wire connection to the blasting machine or power source terminals to be sure that the contacts are good.
- Make two or three more attempts to fire the circuits.
- Try to fire again, using another blasting machine or power source, or change operators.
- Use secondary firing system for dual firing systems.
- Disconnect the blasting machine firing wire and wait 30 minutes before further investigation. Ensure that the firing wires at the power source end of the circuit are shunted to avoid any possible static electric detonation before moving on to the charge site.
- Check the entire circuit, including the firing wire, for breaks and short circuits.

- If the fault is not above ground, remove the tamping material from the borehole very carefully to avoid striking the electric blasting cap.
- **Do not** attempt to remove either the primer or the charge.
- If the fault is not located by removing the tamping material to within 1 foot of the charge, place a new electric primer and 2 pounds of explosive.
- Disconnect the blasting cap wires of the original primer from the circuit, and short the cap's lead wires.
- Connect the wires of the new primer in their place.
- Replace the tamping material.
- Initiate detonation. The new primer will fire the original charge.

NOTE: In some cases, it may be better to drill a new hole within a foot of the old one at the same depth to avoid accidental detonation of the old charge. Place and prime a new 2-pound charge

Premature Detonation by Induced Currents and Lightning

Induced currents. The premature detonation of electric blasting caps by induced current from radio-frequency signals is possible. Table 2-1 on page 2-7 lists the minimum distances from transmitters for safe electrical blasting. This table applies to operating radio, radar, microwave, and television transmitting equipment. Mobile transmitters and portable transmitters are prohibited within 50 meters of any electric blasting caps or electrical firing systems. If blasting distances are less than those shown in Table 2-1 on page 2-7, the only safe procedure is to use a nonelectric system, which cannot be prematurely detonated by radio-frequency currents. If using the electric system is necessary, follow precautions given in TM 9-1300-206 and Army Regulation (AR) 385-63.

NOTE: Radar and microwave transmissions are directed. Therefore, be careful in determining the primary direction of the transmissions.

WARNING

If electric blasting caps are to be transported near operating transmitters or in vehicles (including helicopters) where a transmitter is used, place the caps in a metal can with a snug-fitting cover with a half-inch or more lap. Do not remove caps from containers near an operating transmitter unless the hazard has been judged acceptable.

Lightning. Lightning is a hazard to both electric and nonelectric blasting charges. A strike or a nearby miss is almost certain to initiate either type of system. If lightning strikes, even when far away from the blasting site, it may cause high local earth currents and shock waves that may initiate electrical firing circuits. The effects are worse when lightning strikes near conducting elements, such as those in buildings, fences, railroads, bridges, streams, and

Detonating Cord Misfires

Failure of nonelectric blasting cap. If a nonelectric blasting cap is attached to the detonating cord and it fails to fire, follow these steps:

- Delay the investigation for at least 30 minutes.
- Cut the detonating cord main line between the blasting cap and the charge.
- Fasten a new blasting cap to the detonating cord.

Failure of electric blasting cap. If an exposed electric blasting cap is fastened to the detonating cord and it fails to fire, follow these procedures:

- Disconnect the blasting machine immediately and investigate.
- Test the blasting circuit for any breaks or short circuits.
- Short the firing wire leads to correct the problem before leaving the firing position.
- Replace the original blasting cap, if necessary.

Failure of detonating cord. If the detonating cord fails to function at the explosion of an exposed electric or nonelectric blasting cap, take the following action:

- Investigate immediately.
- Attach a new blasting cap to the detonating cord, taking care to fasten it properly.

Failure of branch line. If the detonating cord main line detonates but a branch line fails, fasten a blasting cap to the branch line and fire it separately.

Failure of charge to explode. If the charge is above ground and the detonating cord leading to a charge detonates but the charge fails to explode, carry out the following procedures:

- Delay investigation until it is certain that the charge is not burning.
- Wait 30 minutes if the charge is below ground.
- Insert a new primer if the charge is intact.
- Reassemble as much of the original charge as possible if the charge is scattered by the detonation of the original detonating cord.
- Place a new charge and reprime, if necessary.
- Make every attempt possible to recover all explosives scattered by misfire, particularly those used in training exercises.

DUAL FIRING SYSTEMS

Overview

There is always a certain amount of danger to personnel investigating misfires. Since misfires are less likely to happen with dual priming, use this method whenever possible. Dual priming consists of two complete systems independent

of each other, each capable of firing the same charge. It can be two electric systems, two nonelectric systems, or an electric and nonelectric system.

Nonelectric Dual Firing System

This system consists of two independent nonelectric systems for firing a single charge or set of charges. If two or more charges are to be fired simultaneously, lay out two detonating cord ring mains and tie each branch line from each charge into each ring main. Figure 2-15 illustrates the layout for a nonelectric dual firing system.

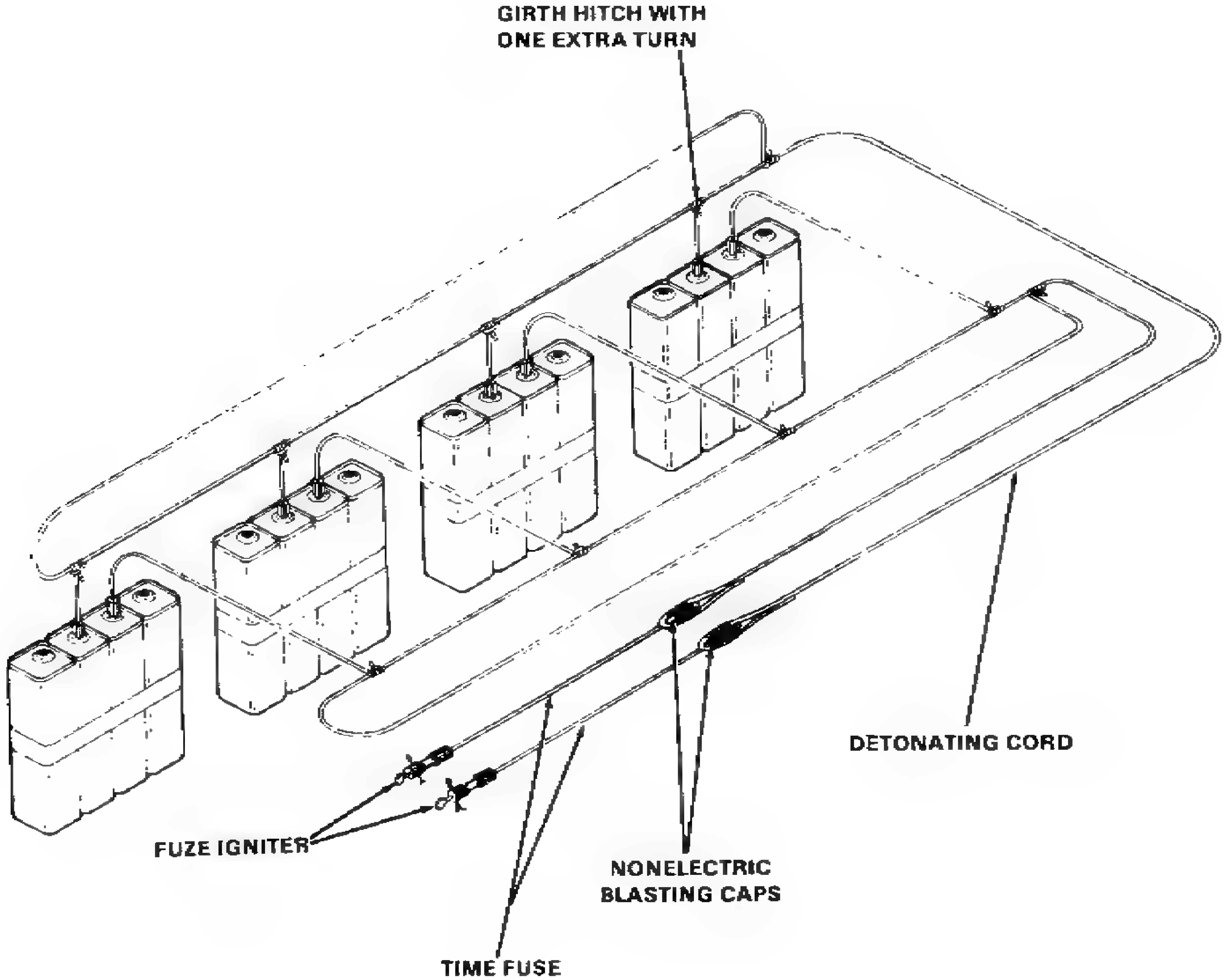


Figure 2-15. Nonelectric dual firing system

Electric Dual Firing System

The electric dual firing system consists of two independent electric circuits. Each circuit has an electric blasting cap in each charge so that the firing of either circuit will detonate all charges. The correct layout is shown in Figure 2-16. Separate the firing wires of the two circuits so the wires will not be cut by a single bullet or a single shell fragment. The firing points must be at two separate locations.

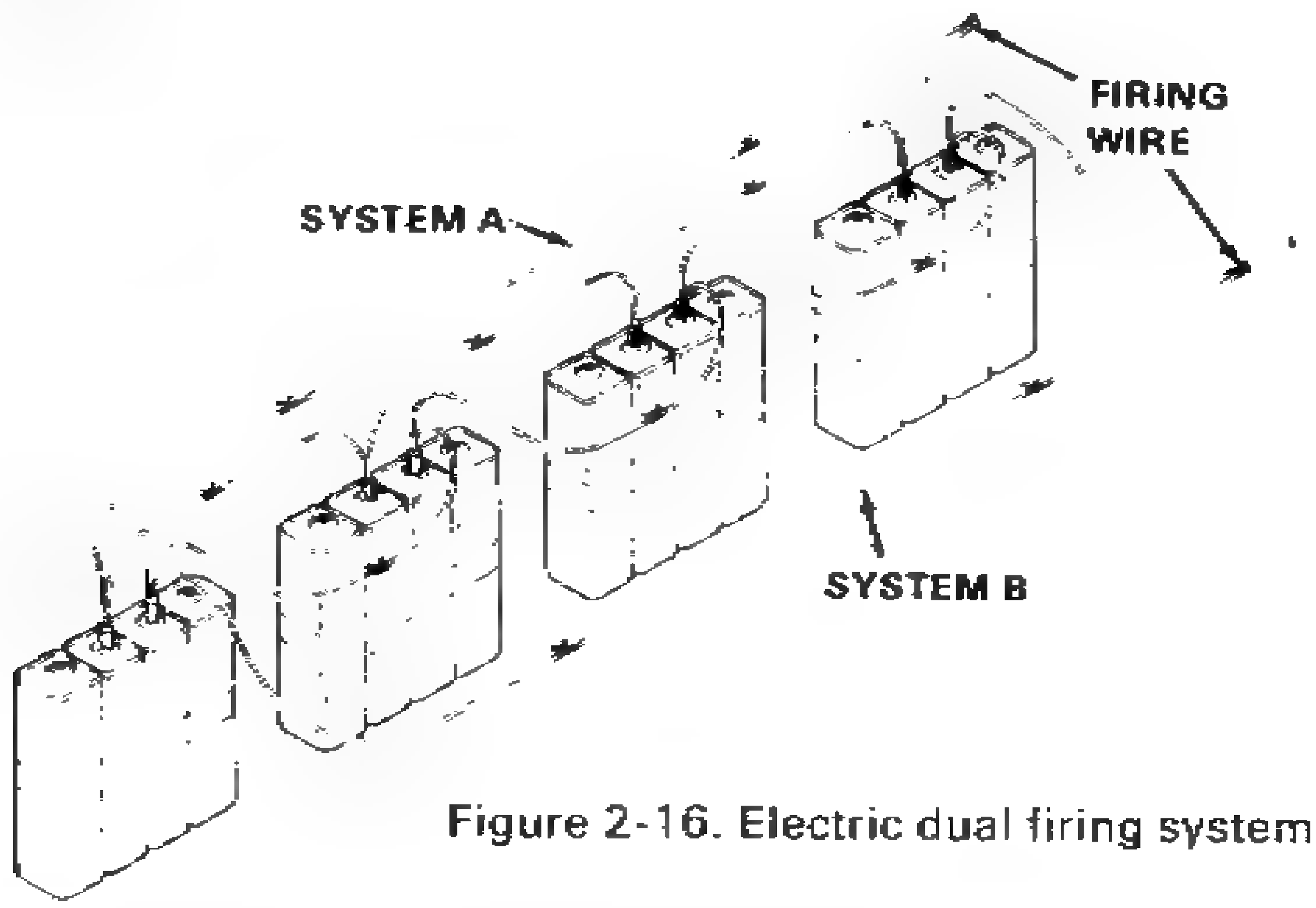


Figure 2-16. Electric dual firing system

Combination Dual Firing System

The combination dual firing system uses an electric and nonelectric firing system (Figure 2-17). Prime each charge electrically and nonelectrically. Each system must be entirely independent of the other. Fire the nonelectric system first.

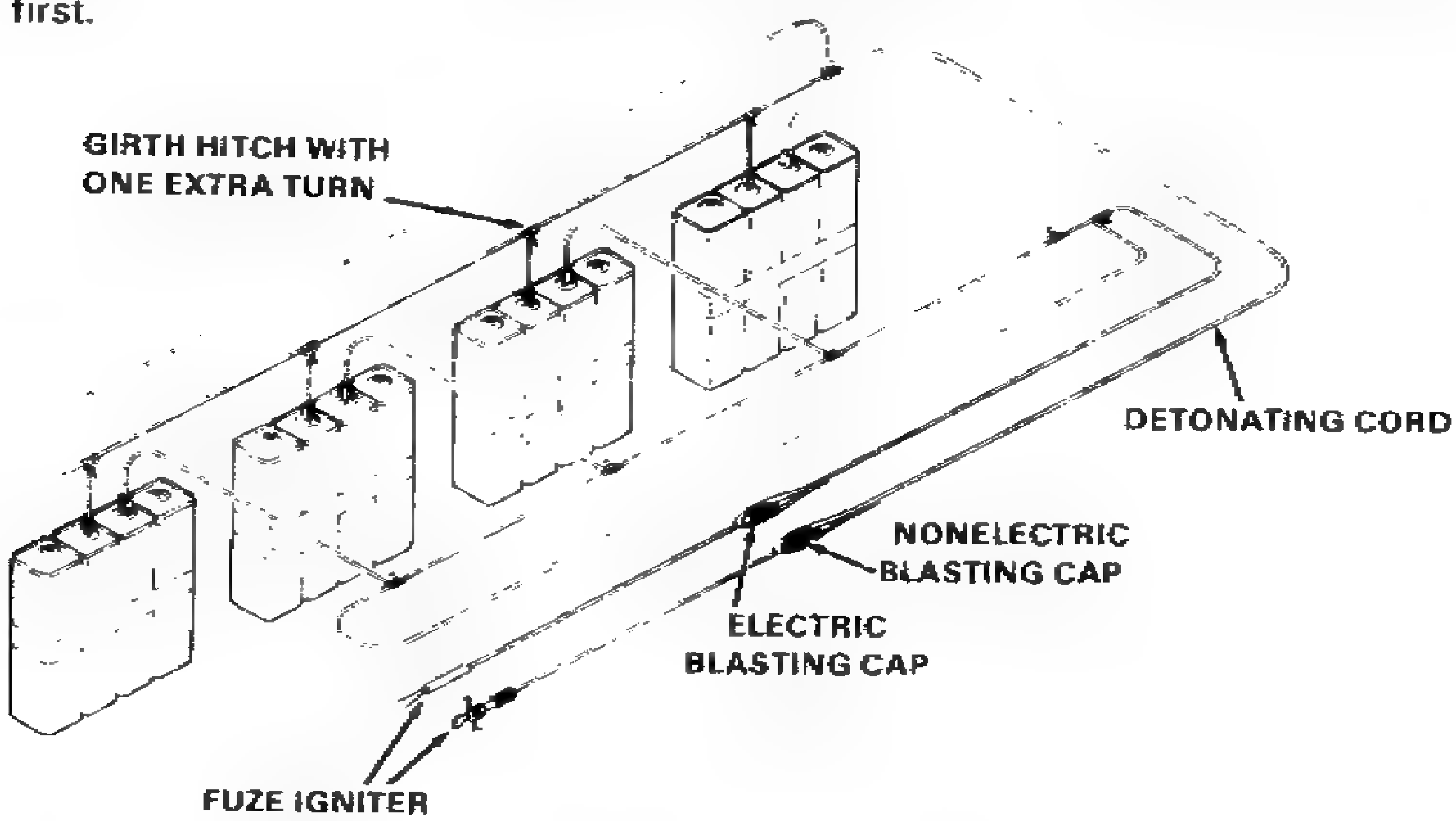


Figure 2-17. Combination dual firing system

PRIMING CHARGES

Overview

The three methods—nonelectric, electric, and detonating cord—of priming most basic explosives are described.

Priming Demolition Blocks

Nonelectric priming. Demolition blocks may have threaded cap wells. Use priming adapters, if available, to secure the nonelectric blasting cap and time blasting fuse to the demolition blocks with threaded cap wells (Figure 2-18).

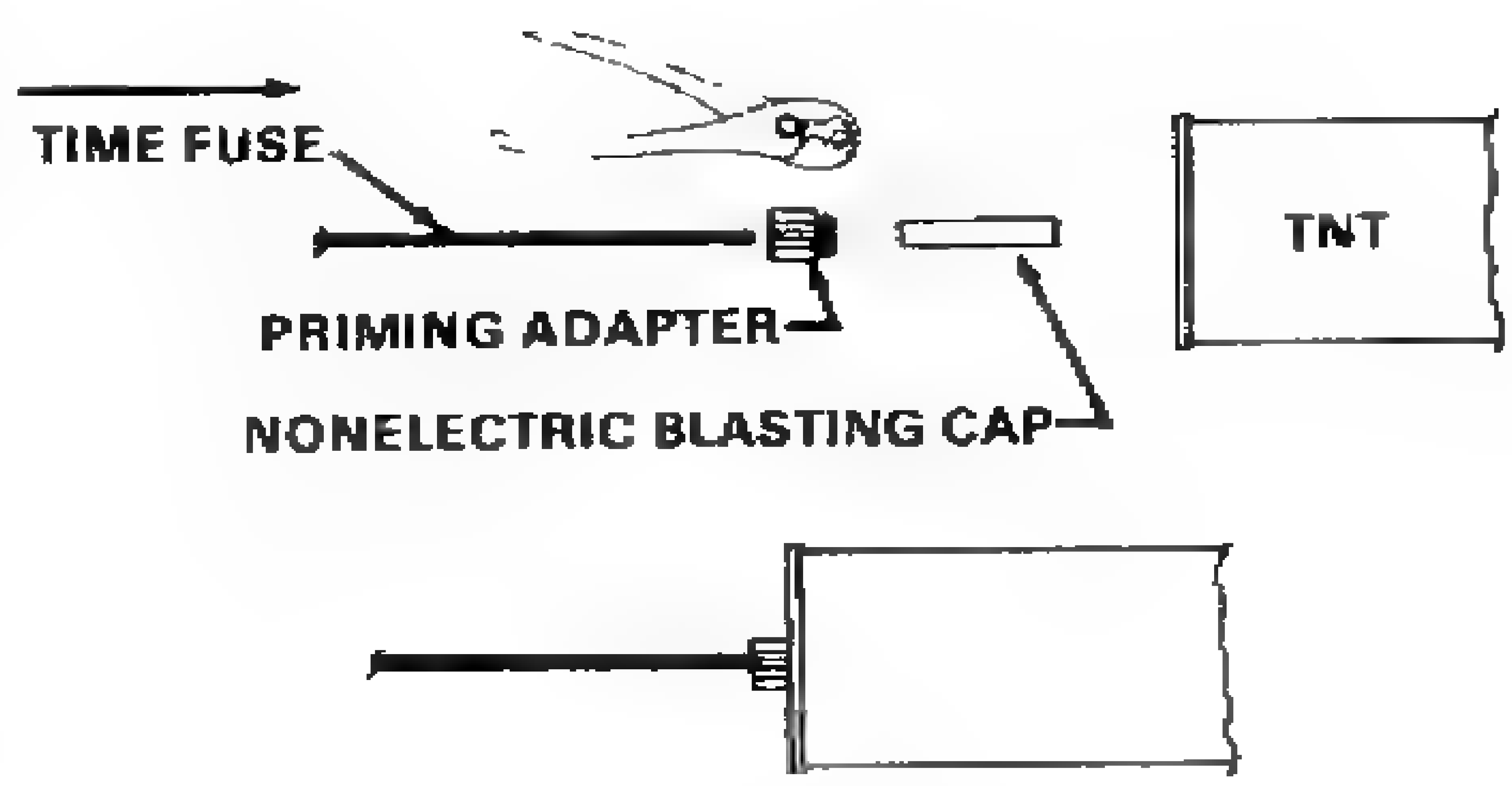


Figure 2-18. Nonelectric priming with priming adapter

When priming adapters are **not** available, prime demolition blocks with threaded cap wells as follows:

- Wrap a string tightly around the block and tie it securely, leaving approximately 6 inches of loose string on each end (Figure 2-19, A).
- Insert a blasting cap with the fuse attached into the cap well.
- Tie the loose string around the fuse to prevent the blasting cap from being separated from the block.

Prime demolition blocks without cap wells as follows:

- Make a hole large enough to contain the blasting cap in the end of the block. Use a pointed nonsparking instrument or the pointed handle on the M2 crimpers (Figure 2-19, B).
- Wrap a string several times around the explosive, and tie a secure knot. Place the tie so that it will be at the top of the hole when the fused cap is inserted.
- Insert fused cap into hole.
- Tie the string around the time fuse at the top of the hole with two half hitches.

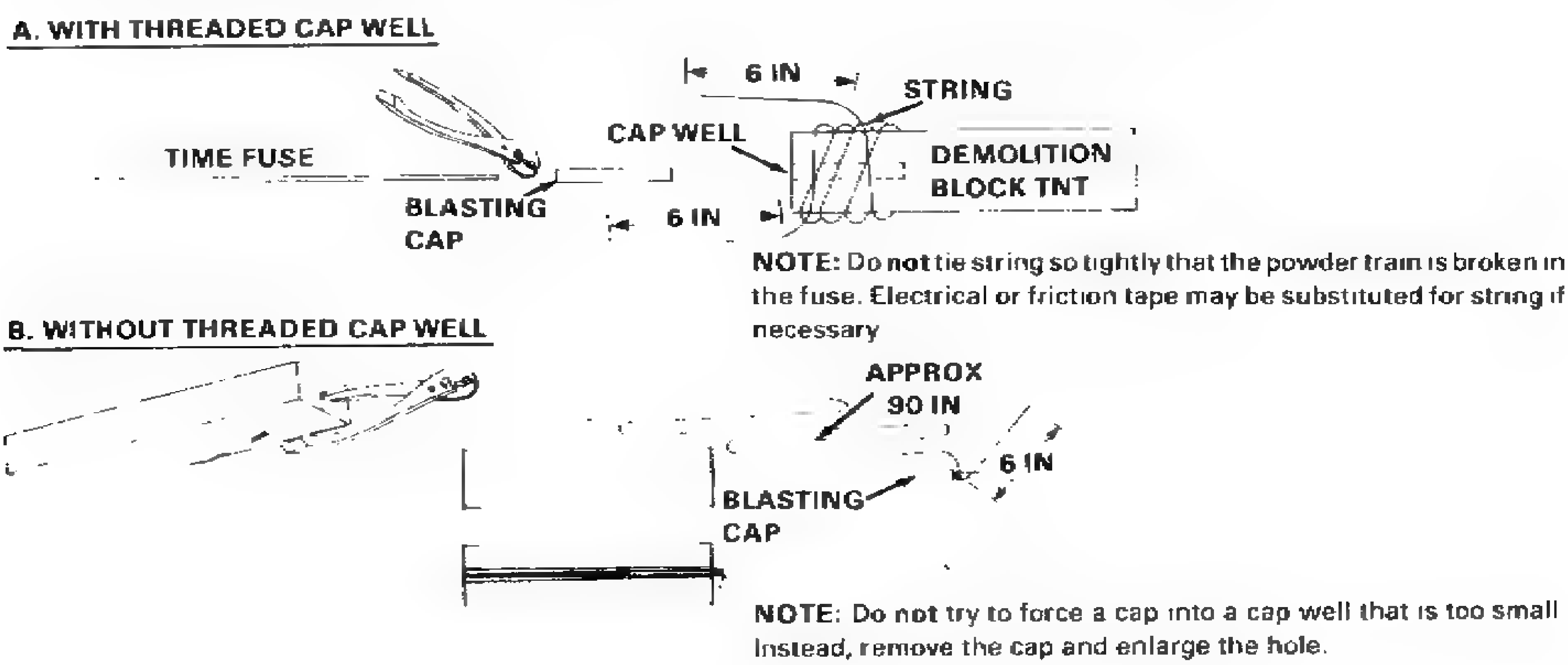


Figure 2-19. Nonelectric priming without priming adapter

Electric priming with priming adapter. If the blocks have threaded cap wells, use priming adapters if available. Perform the following steps for electric priming with priming adapter:

- Untwist the free ends of the lead wire, and fasten them to the firing wire.
- Pass the lead wires through the slot of the adapter, and pull the cap into place in the adapter (Figure 2-20).
- Insert the cap into the cap well of the explosive, and screw the adapter in place.

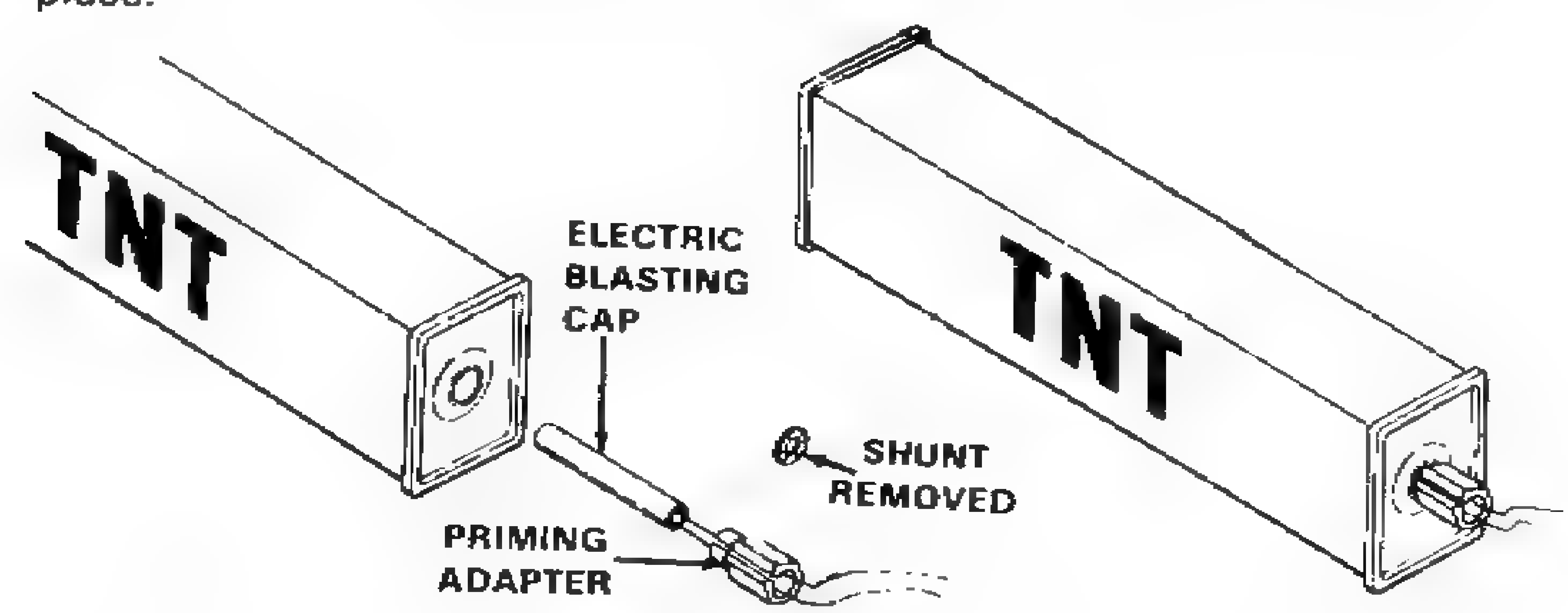


Figure 2-20. Electric priming of demolition block with priming adapter

Electric priming without priming adapter. If a priming adapter is **not** available, perform the following steps:

- Make a cap well, if the block does not have one, as shown in Figure 2-19, B on page 2-21.
- Untwist the free ends of the lead wire, and fasten them to the firing wire.
- Insert the electric cap into the cap well, and tie the lead wires around the block by two half hitches or a girth hitch (Figure 2-21). Allow some slack in the wires between the blasting cap and the tie to prevent any pull on the blasting cap.

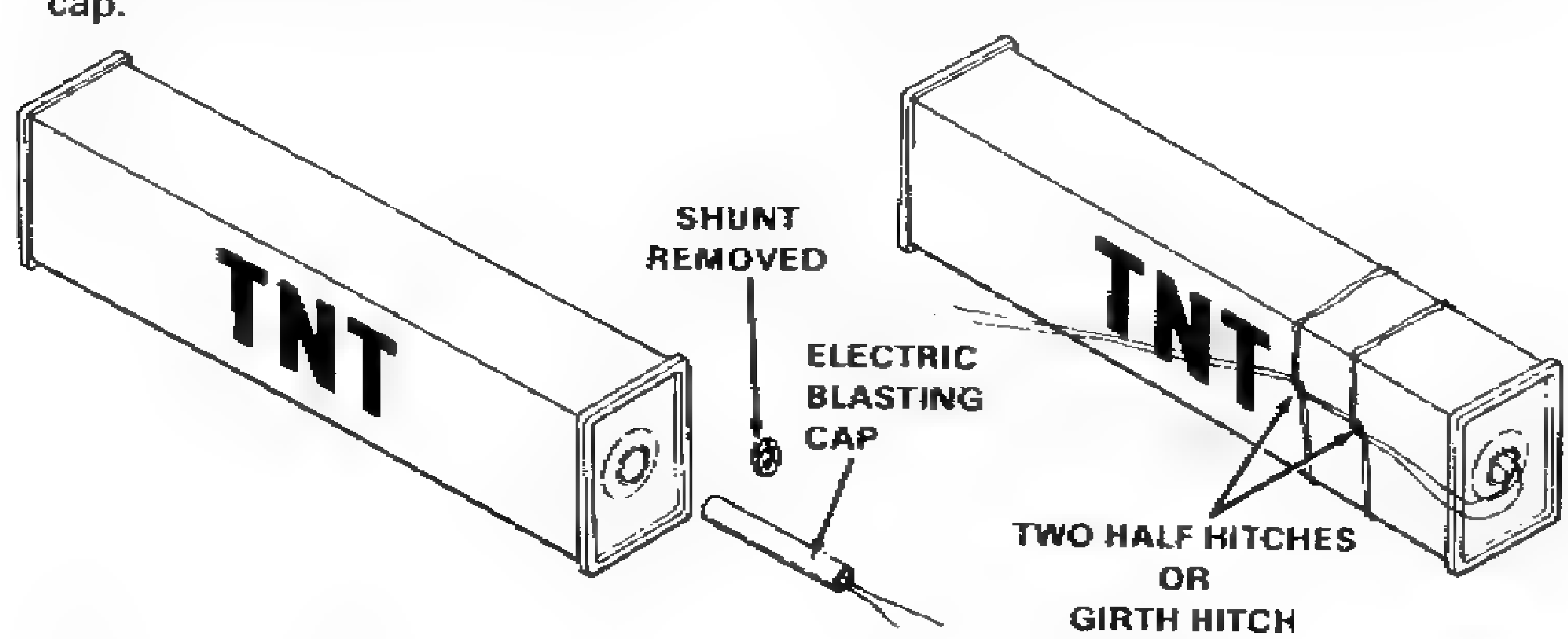


Figure 2-21. Electric priming of demolition block without priming adapter

Detonating cord priming. Demolition blocks can be primed with detonating cord in several ways.

NOTE: A 6-inch length of detonating cord equals the power output of a blasting cap. However, it will not detonate explosives as reliably as a cap because its power output is not as concentrated.

Use the methods that follow to prime demolition blocks with detonating cords.

The most reliable method is to affix a nonelectric blasting cap to the end of the detonating cord and place it in the demolition block in the same way as for nonelectric priming. Initiate the assembly by an electric or nonelectric system.

The common method is shown in Figure 2-22. Lay one end of a 4-foot length of detonating cord at an angle across the explosive. Then give the running end three wraps around the block, and lay the end at an angle. On the fourth wrap, slip the running end under all wraps parallel to the other end and draw tight. Initiate by an electric or nonelectric system.

Alternate method number 1 is shown in Figure 2-22. Tie the detonating cord around the explosive block (on top of the booster, if present) with a clove hitch and two extra turns. Fit the cord snugly against the blocks, and push the loop close together. Initiate by an electric or nonelectric system.

Alternate method number 2 is shown in Figure 2-22. Place a loop of detonating cord on the explosive with four wraps around the block and loop. Ensure that in starting the first wrap that it immediately goes over the short leg of the loop. Pull the running end through the eye of the loop and tighten. Initiate by an electric or nonelectric system.

NOTE: Alternate method number 2 is more applicable to short than long detonating cord branch lines or primers.

Alternate method number 3 is shown in Figure 2-22. Form a Uli knot with a minimum of eight wraps using a 20- to 24-inch length of detonating cord. This knot equals the power output of three to four blasting caps. Tape the knot tightly to the demolition charge to be detonated.

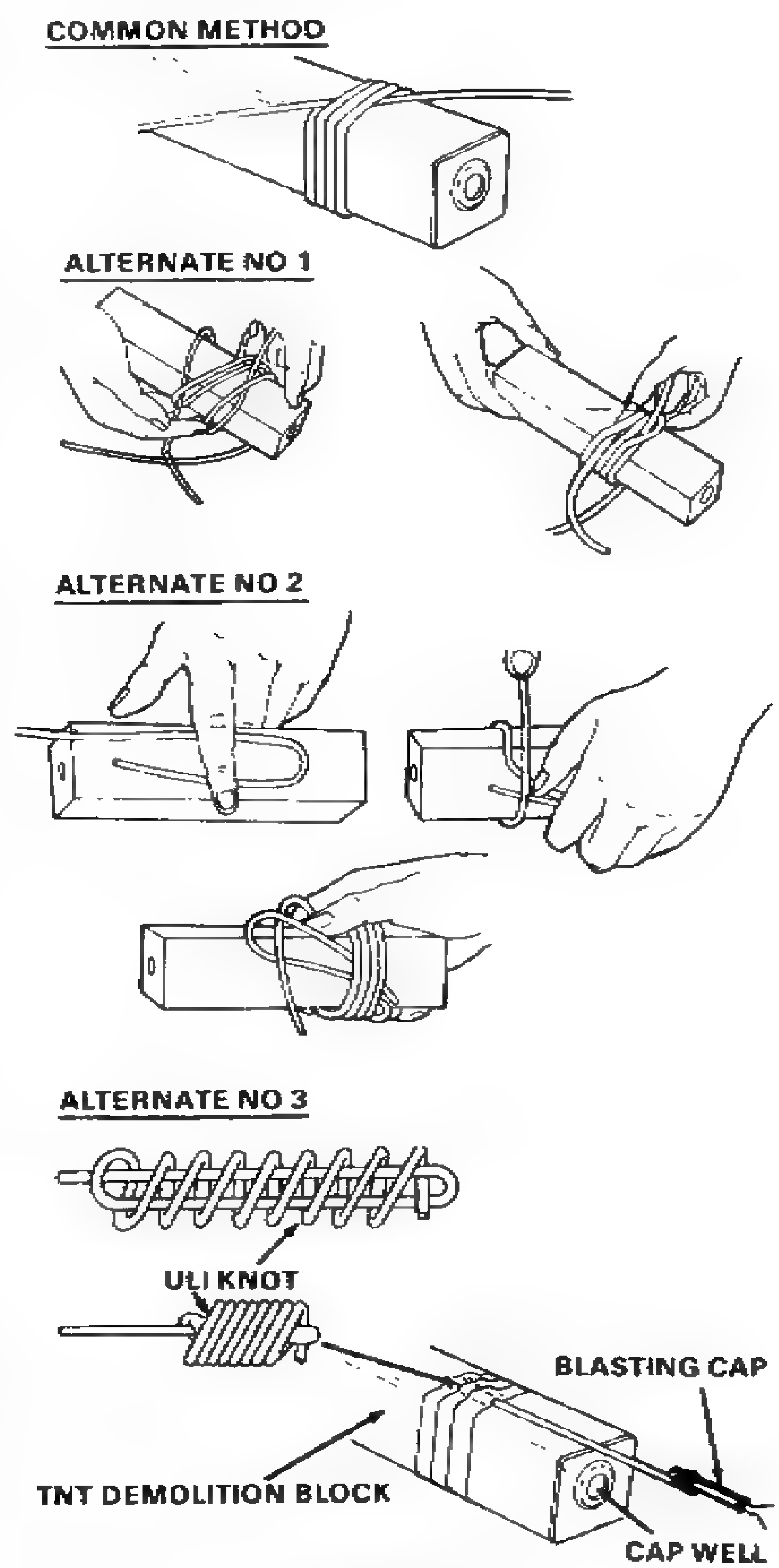


Figure 2-22. Detonating cord priming of demolition blocks

Composition C4 Demolition Blocks

Nonelectric and electric priming. Use whole blocks or portions of blocks of plastic explosives (Composition C4), and prime the same way as demolition blocks without cap wells. Cut plastic explosives with a knife and form into any shape.

Detonating cord priming. To prime plastic explosives with detonating cord, form either of the three knots shown in Figure 2-23.

Insert the knot into a block of explosive or a molded piece of explosive. For positive detonation, ensure that there is at least ½ inch of explosive on all sides of the knot.

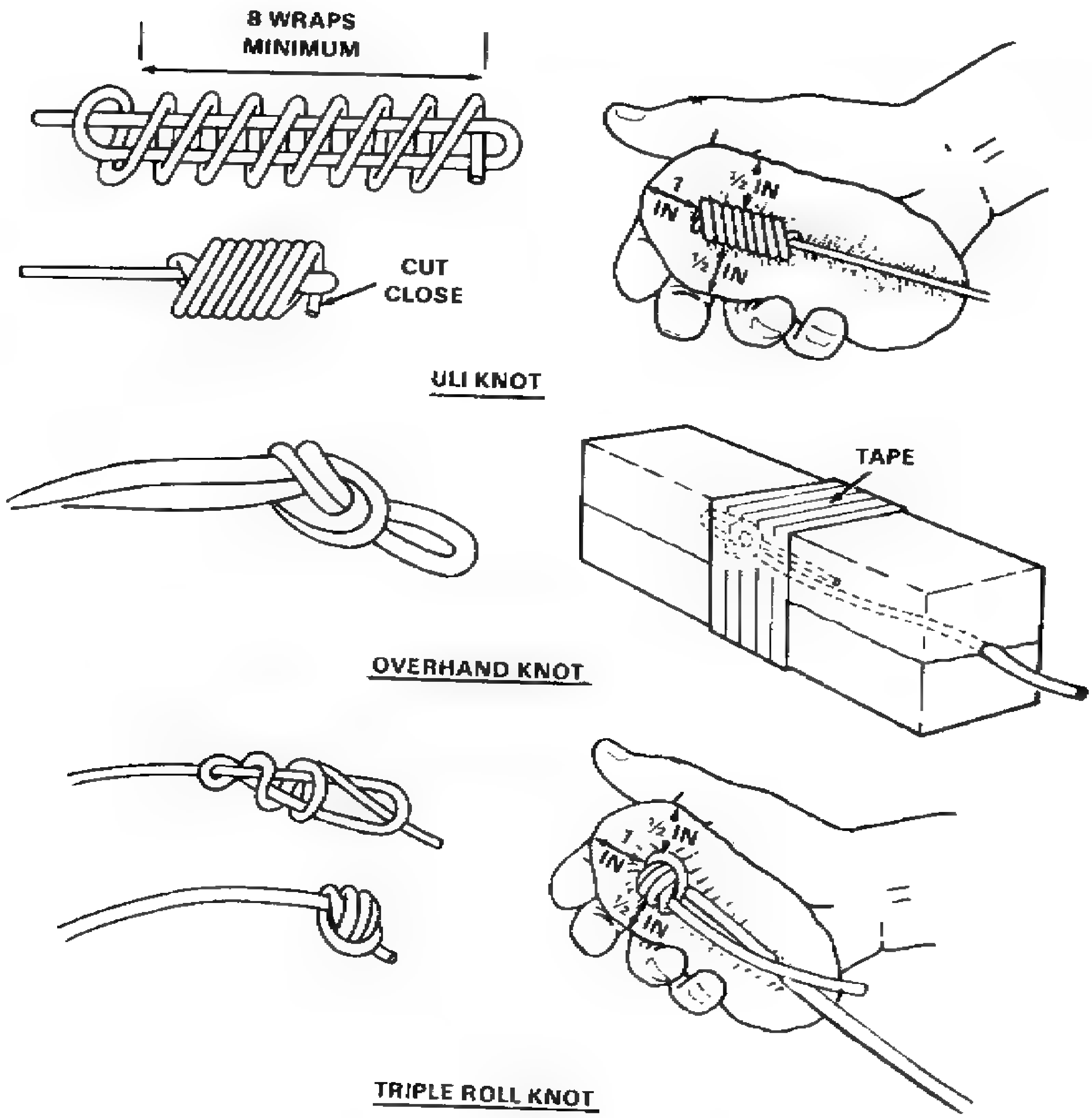


Figure 2-23. Detonating cord priming of plastic explosive

Sheet Explosive (M118 and M186 Demolition Charges)

Nonelectric and electric priming. The M118 and M186 demolition charges can be primed as follows:

- Attach M8 blasting cap holder to one end or side of sheet explosive, and insert the electric or nonelectric blasting cap in the holder until the end of the cap presses against the sheet explosive. The M8 blasting cap holder fastens to the sheet explosive with three slanted protruding teeth which prevent withdrawal. Two dimpled spring arms firmly hold the blasting cap in the M8 holder (Figure 2-24).
- Cut notch approximately 1½ inches long and ¼ inch wide in the sheet explosive, and insert the blasting cap to the limit of the notch. Secure the blasting cap with a strip of sheet explosive (Figure 2-24).
- Place the blasting cap on top of the sheet explosive and secure with a strip of sheet explosive at least 3 inches by 3 inches.
- Insert the end of the blasting cap 1½ inches between two sheets of the explosive.

NOTE: The M-8 holder is supplied in each M118 and M186 demolition charge of recent manufacture. It is also available as a separate item of issue in quantities of 4,000.

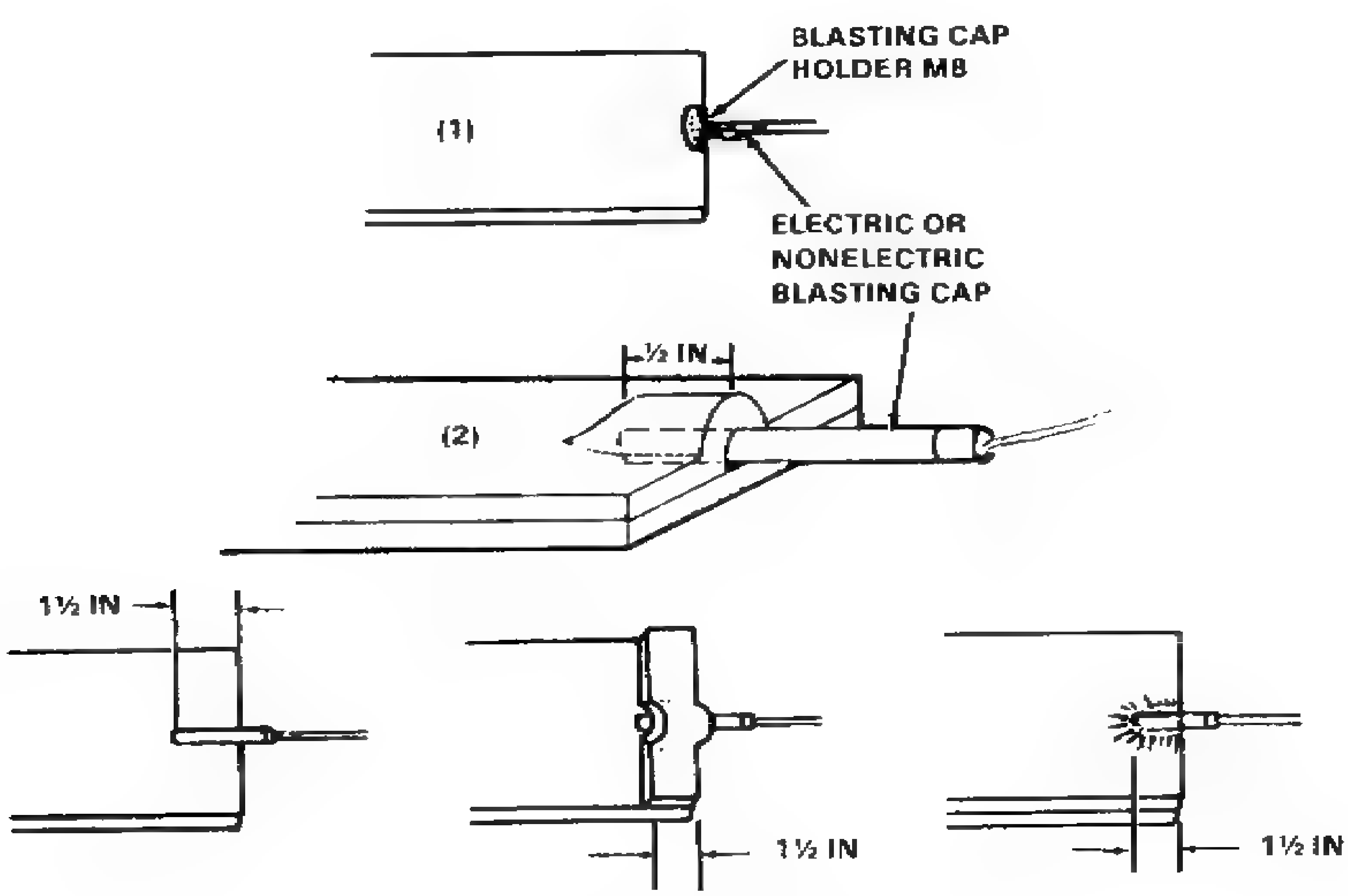


Figure 2-24. Priming sheet explosive

Detonating cord priming. Prime the M118 and M186 demolition charge sheet explosive with the detonating cord by attaching a nonelectric blasting cap to the end of the detonating cord. Then follow the same steps as for priming sheet explosive described above. Sheet explosive can also be primed with detonating cord using a Uli knot. Cover both the blasting cap and the Uli knot with a strip of sheet explosive and connect to an electric or nonelectric firing system.

Dynamite

Prime dynamite at either end or side. Use end priming when a whole case is fired and the placed charges require no tamping. Use side priming when the charge is placed in a tamped borehole to prevent damage to the primer during placement and tamping.

Nonelectric priming methods. There are three possible methods that can be used to prime dynamite nonelectrically.

One is the end priming method (Figure 2-25, A). Prime as follows:

- Make a cap well in the end of the dynamite cartridge using the cap crimpers.
- Insert a fused blasting cap.
- Tie the cap and fuse securely in the cartridge with a string.

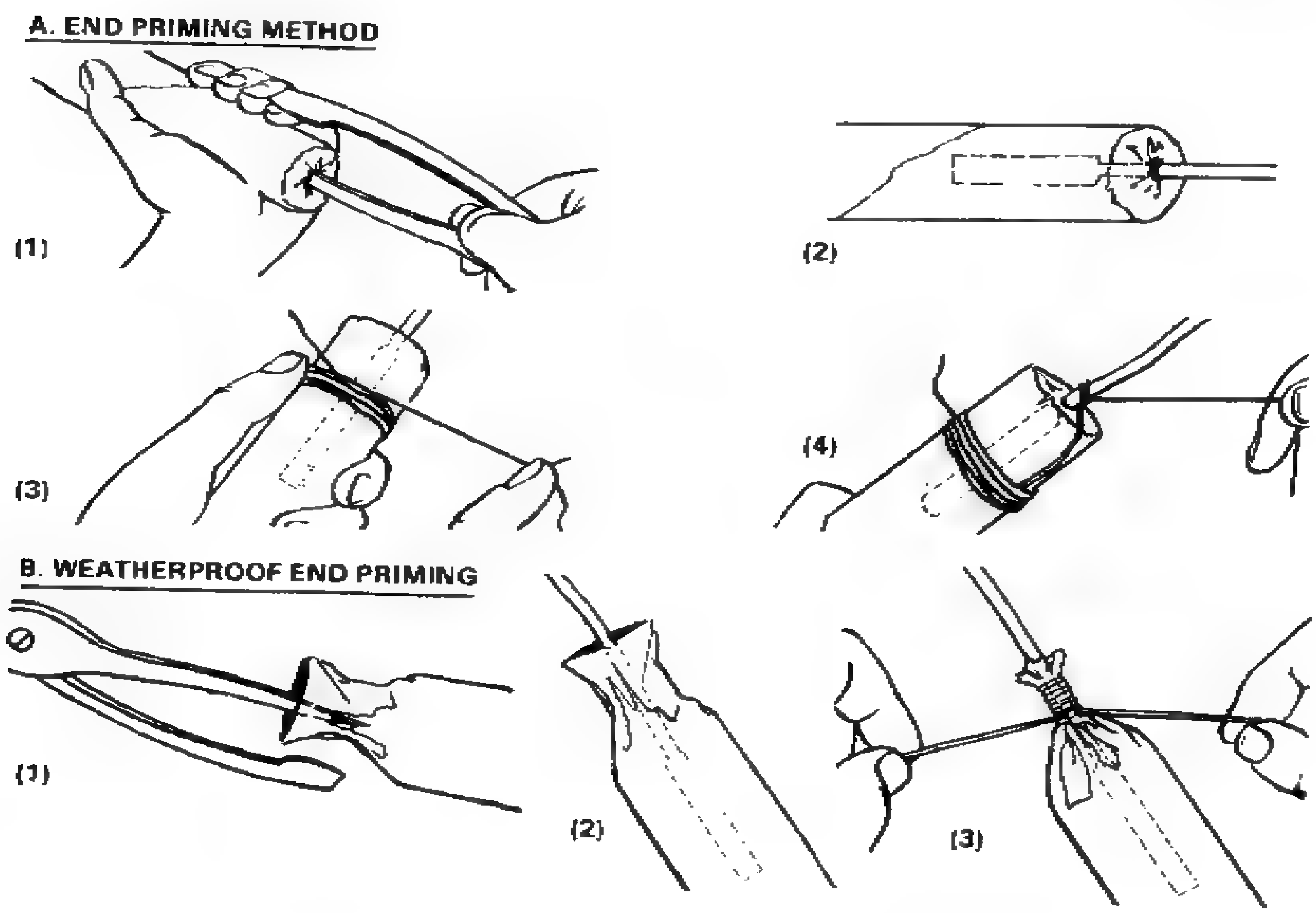


Figure 2-25. Nonelectric end priming of dynamite

A second is the weatherproof end priming method (Figure 2-25, B). Follow these steps:

- Unfold the wrapping at the folded end of the dynamite cartridge.
- Make a cap well in the exposed dynamite using the cap crimpers.
- Insert a fused blasting cap into the cap well.
- Close the wrapping around the fuse and fasten securely with a string or tape.
- Apply weatherproof sealing compound to the tie.

A third is the side priming method (Figure 2-26). Prime as follows:

- Make a cap well about 1½ inches from one end of the dynamite cartridge using the cap crimpers. Slant the cap well so that the blasting cap, when inserted, will be nearly parallel with the side of the cartridge and the explosive end of the cap will be at a point nearest the middle of the cartridge.
- Insert a fused blasting cap into the hole.
- Tie a string securely around the fuse, and then wrap it tightly around the cartridge, making two or three turns before tying it.
- Weatherproof the primed cartridge by wrapping a string closely around the cartridge, extending it an inch or so on each side of the hole to cover it completely. Cover the string with a weatherproof sealing compound.

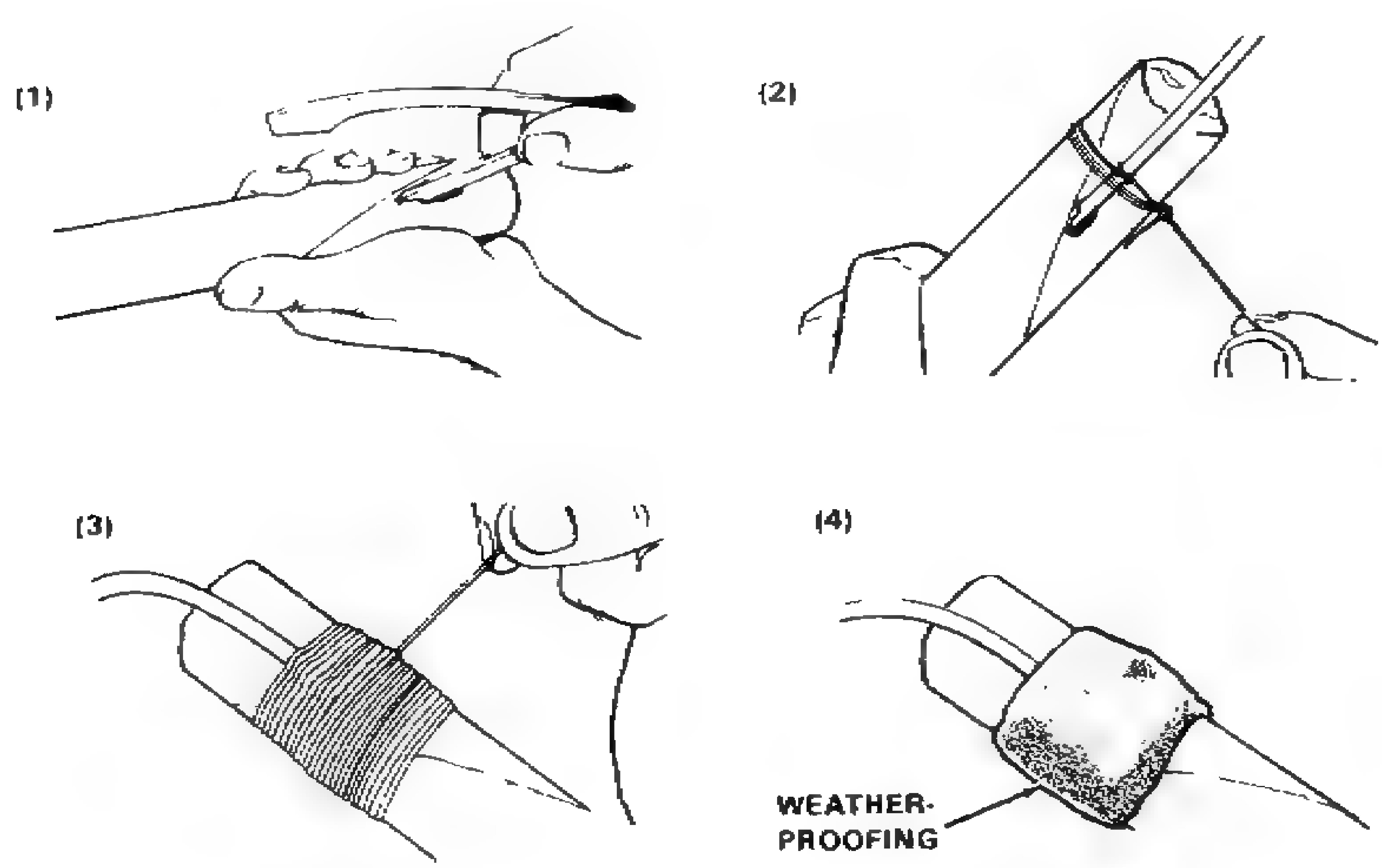


Figure 2-26. Nonelectric side priming of dynamite

Electric priming methods. Electric priming methods include end priming and side priming.

To execute the end priming method, shown in Figure 2-27, A, follow these steps:

- Make a cap well in the end of the cartridge, and insert an electric blasting cap using the cap crimpers.
- Tie the lead wires around the cartridge with a girth hitch or two half hitches.

If side priming is to be done, as shown in Figure 2-27, B, follow these procedures:

- Make a cap well in the side of the cartridge, and insert an electric blasting cap.
- Tie the lead wire around the cartridge with a girth hitch or two half hitches or fasten with a string or tape.

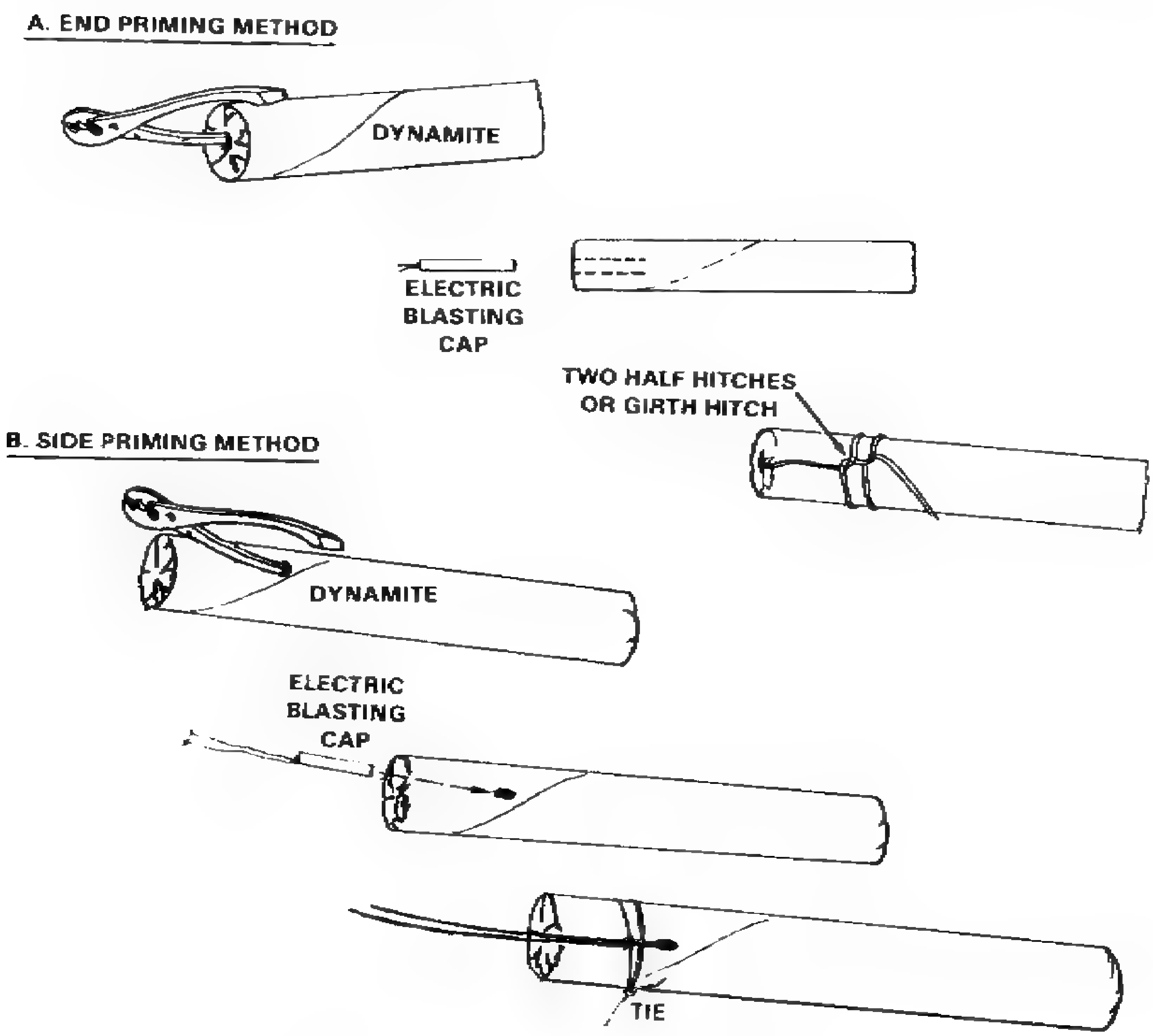


Figure 2-27. Electric priming of dynamite

Detonating cord priming. Prime the dynamite cartridges with the detonating cord by attaching a nonelectric blasting cap to the end of the detonating cord and following any of the methods outlined for nonelectric priming of dynamite.

Dynamite can also be primed by lacing the detonating cord through it. This method is used chiefly in boreholes, ditching, or removal of stumps. Punch four equally spaced holes through the dynamite cartridge, and lace the detonating cord through them as shown in Figure 2-28.

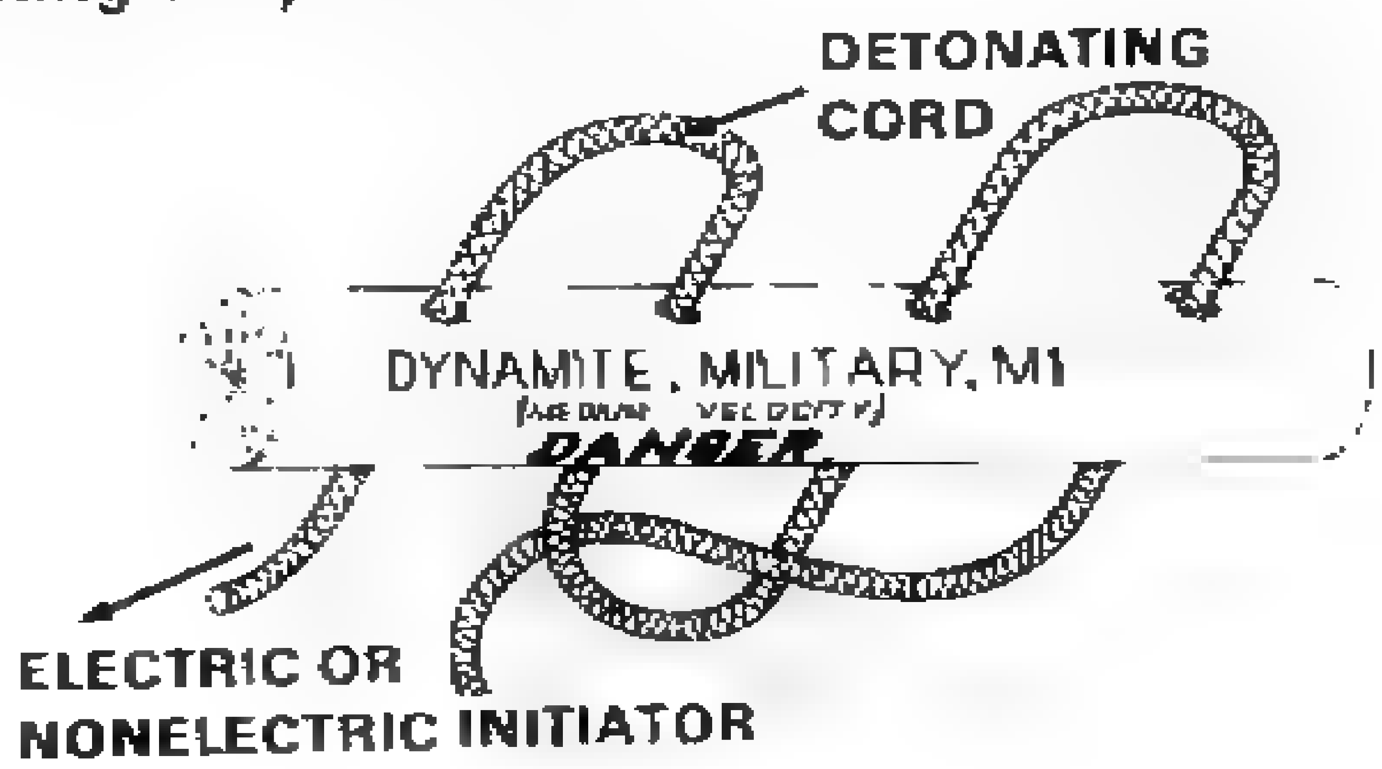


Figure 2-28. Detonating cord priming of dynamite

Forty-Pound Ammonium Nitrate Cratering Charge

Nonelectric priming. To perform nonelectric priming, as shown in Figure 2-29, follow these steps:

- Place a fused nonelectric blasting cap in the cap well on the side of the container.
- Tie a string around the fuse and then around the cleat above the cap well.
- Dual prime as illustrated in Figure 2-30, page 2-30.

Electric priming. Electric priming, as shown in Figure 2-29, is done by following these steps:

- Place an electric blasting cap in the cap well on the side of the container.
- Tie the lead wires around the cleat above the cap well.
- Dual prime.

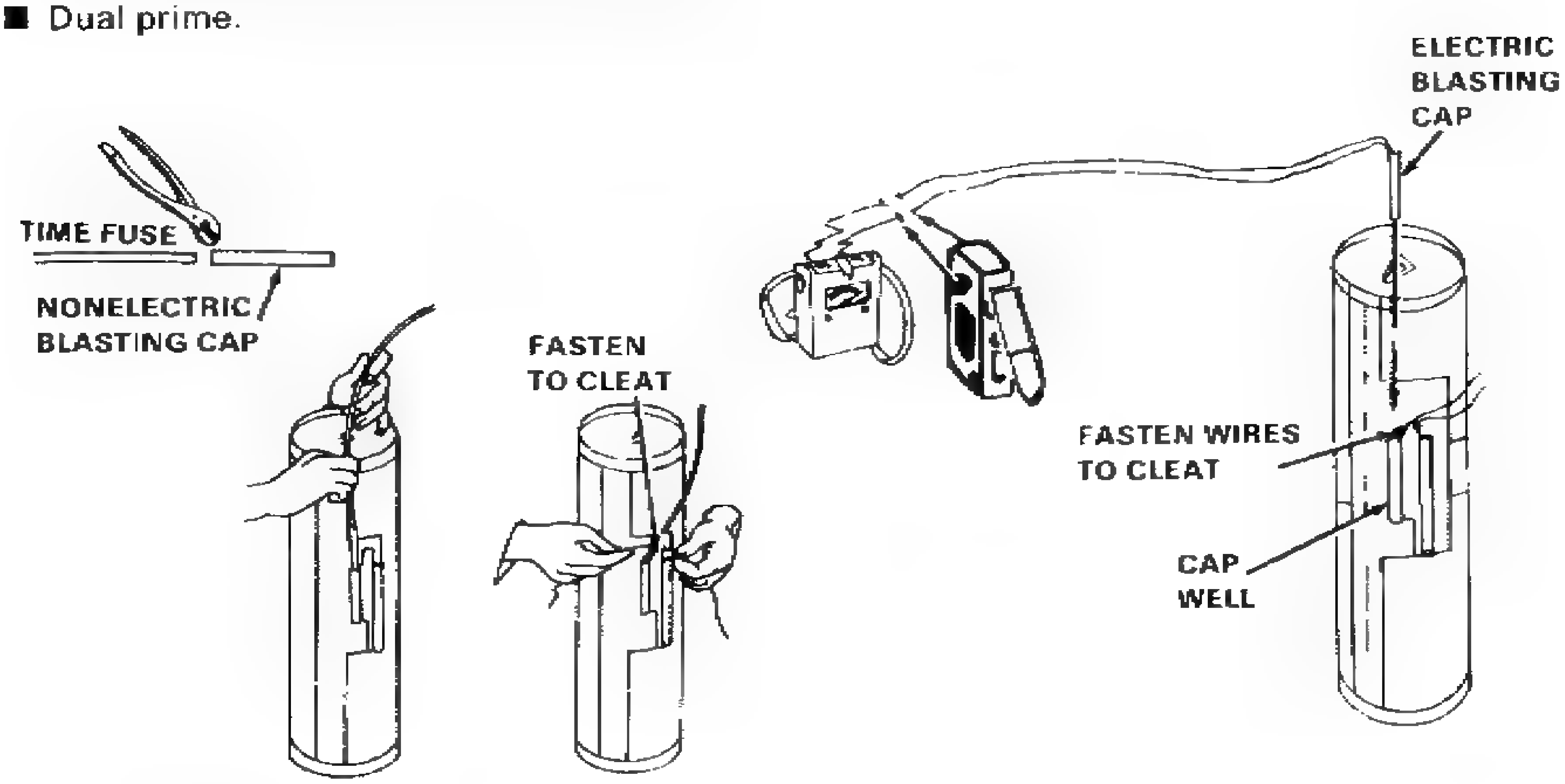
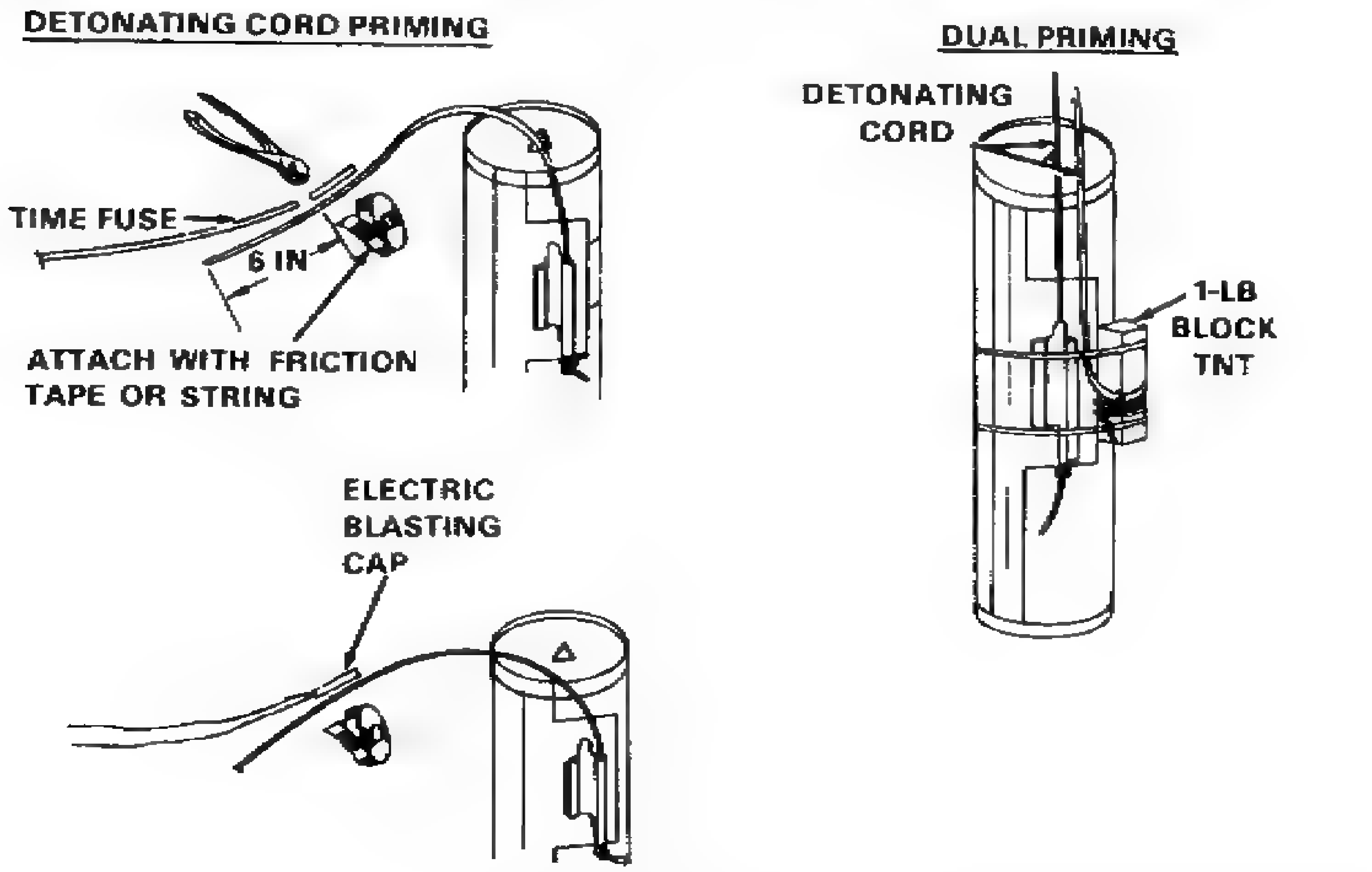


Figure 2-29. Nonelectric and electric priming of ammonium nitrate cratering charge

Detonating cord priming. When priming with detonating cord, as shown in Figure 2-30, follow these procedures:

- Pass the end of the detonating cord through the tunnel on the side of the can.
- Tie an overhand knot at least 6 inches from the end of the portion passed through the tunnel to ensure firing from a dry end.
- Dual prime as described in the paragraph that follows.

Dual priming. The dual priming method is shown in Figure 2-30. Dual prime to ensure positive detonation of the ammonium nitrate cratering charge. Tape a 1-pound block of TNT or one package of C4 to the side of the charge near the cap well or detonating cord tunnel to detonate the TNT booster in the center of the charge. Prime the demolition block in the same way as the cratering charge. Prime both charges so that detonation will be simultaneous.



NOTE: If side placement of a 1-pound block of explosive is not possible, bottom placement is better than top placement to achieve dual priming.

Figure 2-30. Detonating cord priming and dual priming of ammonium nitrate cratering charge

Precautions. Ammonium nitrate absorbs moisture and becomes ineffective. Therefore, inspect the metal container for damage or rusting. Do **not** use damaged or rusty charges. For safety in priming, use detonating cords whenever charges are placed underground.

Shaped Charges

Nonelectric and electric priming. The M2A3, M2A4, M3, and M3A1 shaped charges have a threaded cap well at the top of the rear cone. They can be primed with a blasting cap and priming adapter as shown in Figure 2-31. A primer can be held in the cap well with a string, a piece of cloth, or tape if a priming adapter is not available.

Detonating cord priming. Prime shaped charges with detonating cord by attaching a nonelectric blasting cap to the end of the detonating cord, and follow the procedure shown in Figure 2-31 substituting detonating cord for a time fuse.

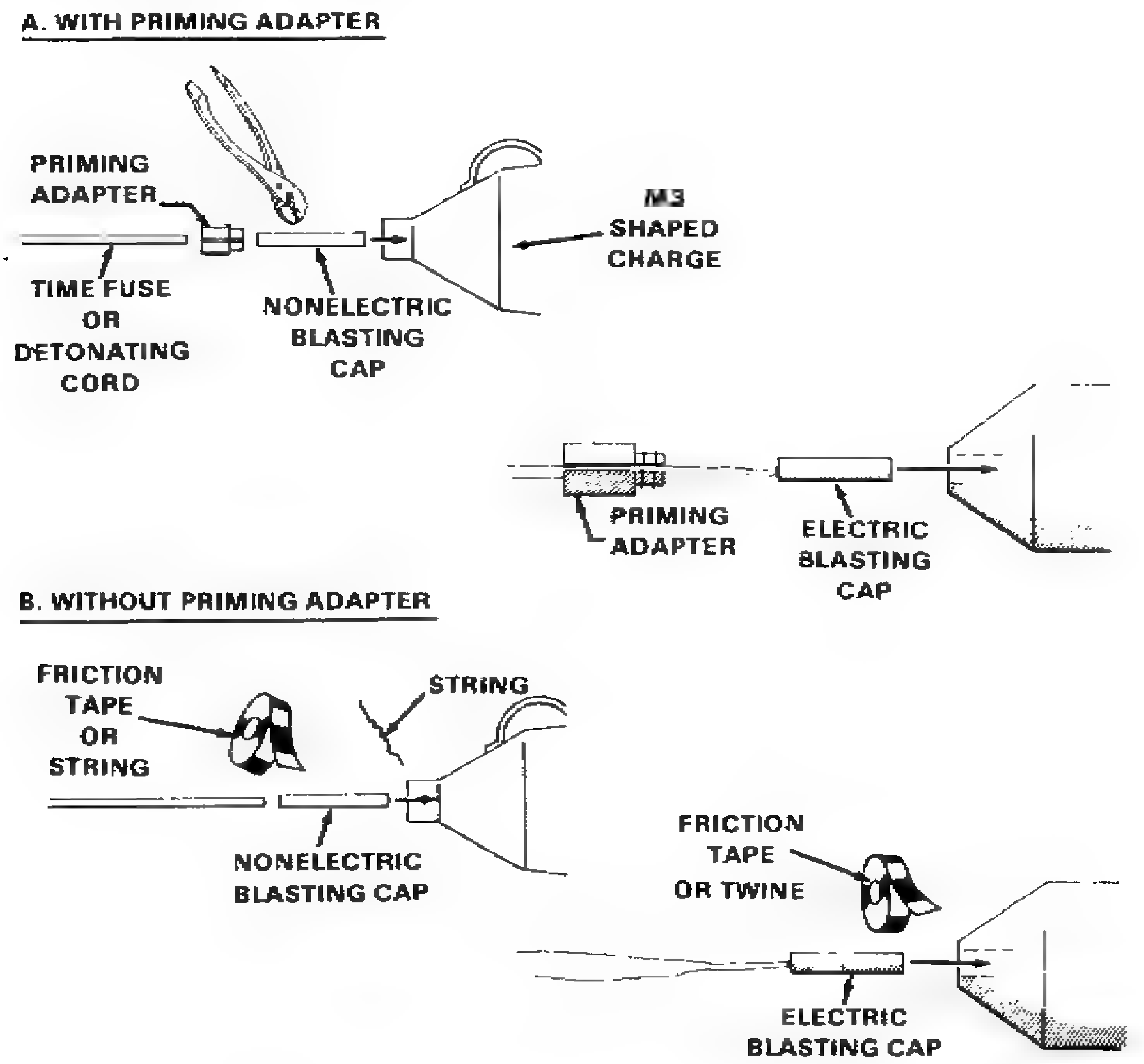


Figure 2-31. Nonelectric and electric priming of shaped charges

Dual priming. Detonate the shaped charges from the center rear of the cone for maximum effectiveness. Conventional methods of dual priming are not applicable to shaped charges.

Bangalore Torpedo

Nonelectric priming. Prime the bangalore torpedo by assembling a length of time blasting fuse and a nonelectric blasting cap in a priming adapter and screwing the assembly into the cap well of a torpedo section (Figure 2-32, A). A section can also be primed nonelectrically by using a pull type of firing device with a nonelectric blasting cap crimped on the standard base and screwed into the cap well (Figure 2-32, B). If no priming adapter is available, insert the blasting cap with fuse into the charge and secure it with a piece of string or tape to prevent it from separating from the charge.

Electric priming. Prime the bangalore torpedo electrically by assembling a blasting cap and priming adapter and screwing the assembly into the cap well of a torpedo section (Figure 2-32, C). Insert the blasting cap into the charge if no priming adapter is available. Tie the lead wires around the charge with two half hitches. Allow some slack in the wires between the blasting cap and the tie to prevent pulling on the blasting cap.

Detonating cord priming. Prime the bangalore torpedo with a length of detonating cord by wrapping the cord at least four times around the cap well at either end in the same way used to prime TNT (Figure 2-22 on page 2-23). Additional wraps may be used. Another method is to crimp a nonelectric cap on the end of the detonating cord. Prime the torpedo using the same method as for nonelectric priming described earlier.

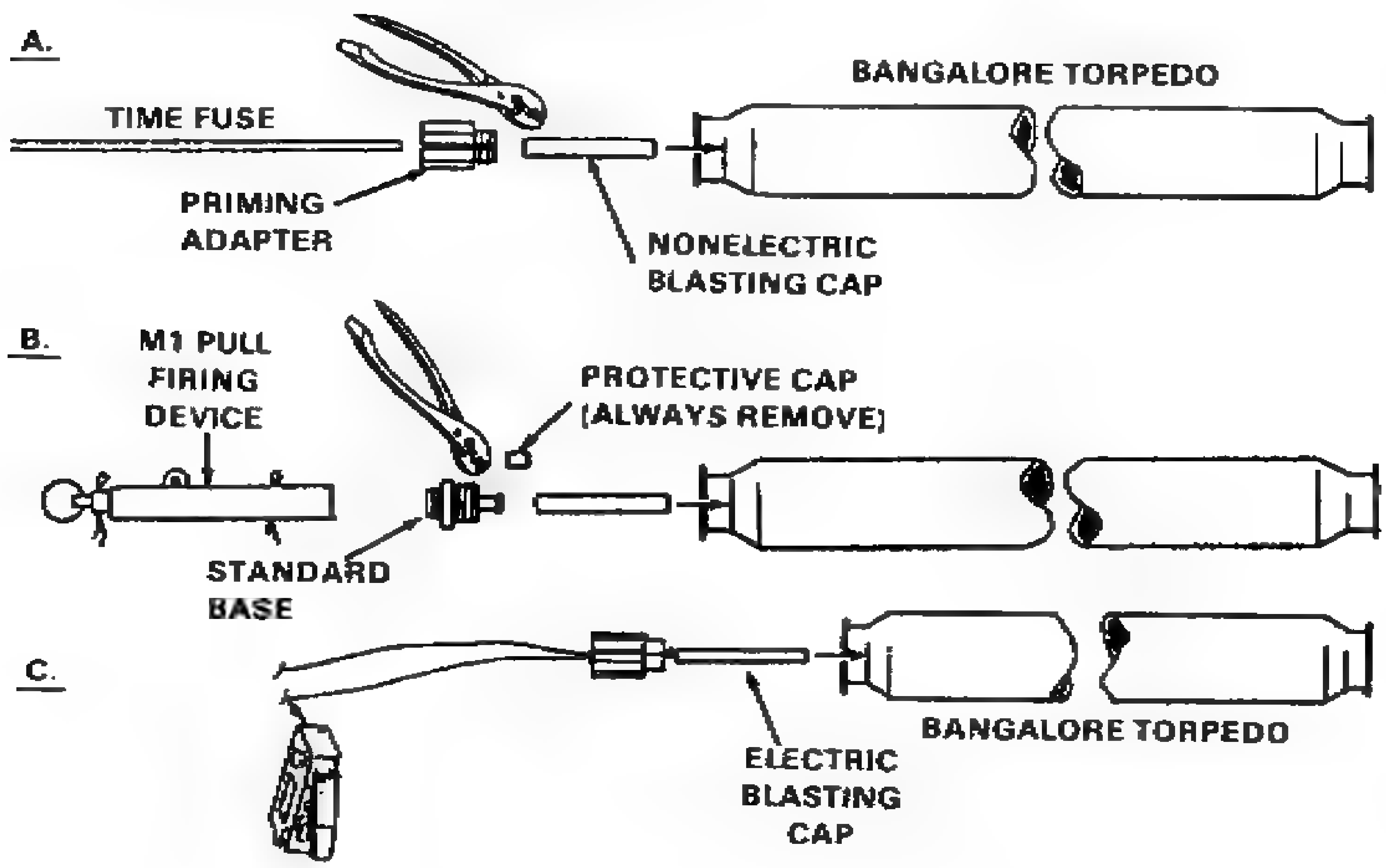


Figure 2-32. Nonelectric and electric priming of bangalore torpedo

calculation and placement of charges 3

The amount and placement of explosives are key factors in a military demolition project. Formulas are used for calculations. Demolition principles and critical factor analysis also guide the soldier in working with charges. This chapter discusses how to accurately determine quantity and placement of charges.

FUNDAMENTAL CONSIDERATIONS

Critical Factors in Charge Calculations

The amount of explosive used in any demolition project is determined by formula calculations based on the following critical factors.

Type and strength of material. A demolition target may be constructed of timber, steel, or other material. Concrete may be reinforced with steel, thereby increasing its strength.

Size and shape of target. Consider the size and shape of the target. For example, large targets, such as concrete piers, and oddly shaped targets, such as steel I-beams, may be attacked more economically by multiple charges than a single charge.

Desired demolition effect. Consider the extent of demolition and other desired effects such as the direction of falling trees to construct an abatis.

Type of explosive. The particular characteristics of each type of explosive determine its application for various demolition projects. They are listed in Table 1-1 on page 1-3 and Table 1-2 on page 1-8.

Size and shape of charge. Calculate the amount of explosive by using demolition formulas. However, when external charges are used without special placement techniques, a flat square charge with a thickness-to-width ratio of 1 to 3 or more will give acceptable results. In general, charges less than 5 pounds should be 1 inch thick. Charges from 5 to 40 pounds should be 2 inches thick. Charges 40 pounds or more should be 4 inches thick.

Charge placement. For cratering, place charges in holes below the ground. For breaking or collapsing stone or concrete, locate the charges on the surface or in boreholes. For cutting timber, tie them on the outside or place in boreholes, whichever is more practical.

Fasten charges to the target by wire, adhesive compound, tape, or string. Prop charges against the target with a wooden or metal frame made of scrap or other available materials, or place in boreholes.

Method of initiation. The method of initiation is not critical except for special types of charges, such as a shaped charge or diamond charge.

Method of tamping. Detonating an explosive produces pressure in all directions. If the charge is not completely sealed or confined, or if the material surrounding the explosive is not equally strong on all sides, the explosive force will escape through the weakest spot. To keep as much explosive force as possible on the desired objective, pack the material around the charge. This material is called tamping material, and the process is called *tamping*. *Stemming* is the process of packing material on top of an internal borehole charge used during quarrying and cratering.

Principles of Demolition

Effects of detonation. When an explosive detonates, the explosive changes violently into compressed gas at an extremely high pressure. The type of explosive and the density, confinement, and dimensions of the charge determine the rate of change. The resulting pressure then forms a compressive shock wave which shatters and displaces objects in its path as it proceeds from its point of origin. A high explosive charge detonated in direct contact with a solid object produces three detectable destructive effects.

The first effect is one in which the surface of the object directly under the explosive charge will be deformed. On a concrete surface, the compressive shock wave crumbles the material in the immediate vicinity of the charge, forming a crater. On a steel target, an indentation or depression, with an area about the size of the contact area of the charge, is made in the surface of the plate.

The second effect is one in which the explosive shock wave chips material to be breached. This is known as *spalling.* If the charge is big enough, the opposite side of the object will spall or chip away. If the target has a free surface on the side opposite the charge, due to the difference in density between the target and the air, the compressive shock wave will be reflected as a tensile shock wave from that free surface. This causes spalling of the target-free surface. On a concrete wall, the crater and spalls may meet to form a hole through the wall. On a steel plate, one spall approximately the shape of the explosive charge is thrown from the plate.

The third effect, which takes place if the explosive charge is large enough, is one in which expanding gases create a pressure load on the object that will cause radial cracking and displacement of material. This effect is known as *cracking.* On concrete walls, cracking may break the wall into a large number of chunks and project them away from the charge position. On steel plates, the material may be bent away from the charge position.

Significance of charge dimensions. The force of an explosion depends on the quantity and power of the explosive. The destructive effect depends on the way the explosive force is directed at the target. To transmit the greatest shock, the best relationship must exist between the area of the charge in contact with the target and the charge thickness. If a calculated charge is spread too thinly, there will not be enough space for the shock wave to reach full velocity before striking the target. The shock wave will tend to travel parallel rather than normal to the surface. As a result, the volume of the target will be too much for the strength of the shock wave. A thick charge with a small contact area will transmit the shock wave over too small a target area with too much lateral loss of energy. For contact steel-cutting charges on structural steel 3 inches thick or less, tests have shown that the best ratio of target thickness to charge width is approximately 1 to 3. The best ratio for reinforced concrete 1 to 7 feet thick ranges from approximately 1 to 6 to about 1 to 14 for rectangular external untamped breaching charges.

Significance of charge placement. The destructive effect of an explosive charge also depends on the contact between the explosive and the target and the location of the charge in relation to target size and shape.

For the most destructive effect, an explosive charge that is the best size and shape for the size and shape of the target must be detonated in close contact with the target. Any significant air or water gap between the target and the explosive will lessen the force of the shock wave. Explosives, such as sheet explosive or plastic explosives, that can be cut or molded to fit odd-shaped targets are better for certain types of targets.

Place explosive charges to act through the smallest part of the target whenever possible. Use internal charges to get the most destruction for the least amount of explosive. Tamping external charges increases their destructive effect.

Types of Charges

Internal charges. Internal charges are placed in boreholes in the target. They are confined by tightly packed sand, wet clay, or other material (stemming). Tamp and pack the stemming material against the explosive to fill the hole to the surface. In drill holes, tamp the explosive (usually dynamite) as it is loaded into the hole. Refer to TM 5-332 for details of quarry practice.

External charges. Place external charges on the surface of the target. Tamp the charges by covering them with tightly packed sand, clay, or other dense material. Tamping may be loose or in sandbags. To be most effective, the thickness of the tamping should at least equal the breaching radius. Small breaching charges on horizontal surfaces are sometimes tamped by packing several inches of wet clay or mud around them. This process is called *mudcapping.*

Charge Selection and Calculation

Charge selection. Selection of an explosive charge for successful demolition operations is a balance between the critical factors listed above and the practical aspects of the type of target, the amount and type of explosives available, the amount and type of material available (such as sandbags), the amount and type of equipment available, the number of personnel available, and, probably most important, the time available to accomplish the mission. Formulas for computing specific charges and methods of their placement are listed in this chapter. Formulas based on metric measurements are listed in Appendix A.

Charge calculation. The formulas in this chapter give the weight of the explosive required for a demolition task P in pounds of TNT. If explosives other than TNT are used, adjust the value of P according to the strength of the other explosives. Compute the adjusted value of P (corrected weight of explosive required) by dividing the P value for TNT by the relative effectiveness factor for the explosive to be used.

Use the problem-solving format for all charge calculations. The six steps to the problem-solving format are as follows:

- Obtain critical dimensions necessary for charge calculation and placement.
- Using the selected demolition formula, calculate the weight of a single charge for TNT to at least two decimals.
- Divide by the relative effectiveness factor, if required.
- Divide by the unit weight of a single package of explosive and **round up** the answer for the single charge to the next higher package size.
- Determine number of charges.
- Multiply the answer for the single charge by the number of charges to obtain the total amount of explosives required.

TIMBER-CUTTING CHARGES

Size and Placement of Charge

Type of explosive used. Use dynamite for tamped internal charges in boreholes. The cartridge size makes it convenient to emplace. It is powerful enough because it is confined. Use a block explosive (TNT, tetrytol, and Composition C4) for untamped concentrated external charges because it is easily tied or fastened to the target. Use plastic explosives (Composition C4) or sheet explosives (M118 or M186) for untamped external ring charges because they are easily fastened to and molded around the target. It is impractical to try to cut all kinds of timber with charges of a size calculated from a single formula. Kinds of timber vary widely from locality to locality. Therefore, **make test shots** to determine the size of the charge to cut a specific type of timber. Formulas for calculating these test shots are given below.

Formula for tamped internal charges. Use the following formula to calculate tamped internal cutting charges:

$$P = \frac{D^2}{250} \text{ or } P = .004\, D^2 \text{ where,}$$

P = pounds of TNT required per tree,

D = diameter or least dimension of dressed timber, in inches, and

$\frac{1}{250}$ = .004 = constant. (1)

Problem—Determine the amount of TNT required to cut one 15-inch-diameter tree, using tamped internal charges, with the formula $P = \frac{D^2}{250}$ given in Equation (1).

Solution—Solve the problem presented as follows:

$$P = \frac{(15)^2}{250} = \frac{225}{250} = 0.90 \text{ or 1 pound of TNT per tree}$$

Internal charge placement. Place the charge in a borehole parallel to the greatest dimension of cross section, and tightly tamp it with moist earth. If the charge is too large for one borehole, make two boreholes side by side in the dimensional timber. On round timber, make two boreholes at approximately right angles to each other, but do not intersect (Figure 3-1). Tamp both boreholes, and fire the charges simultaneously.

Formula for untamped external charges. Use the following formula for cutting trees, piles, posts, beams, or other timber members using explosives as an untamped external charge:

$P = \frac{D^2}{40}$ or $P = .025\ D^2$ where,

P = pounds of TNT required per tree,

D = diameter of round timber, or least dimension of dressed timber, in inches, and

$\frac{1}{40}$ = .025 = constant. (2)

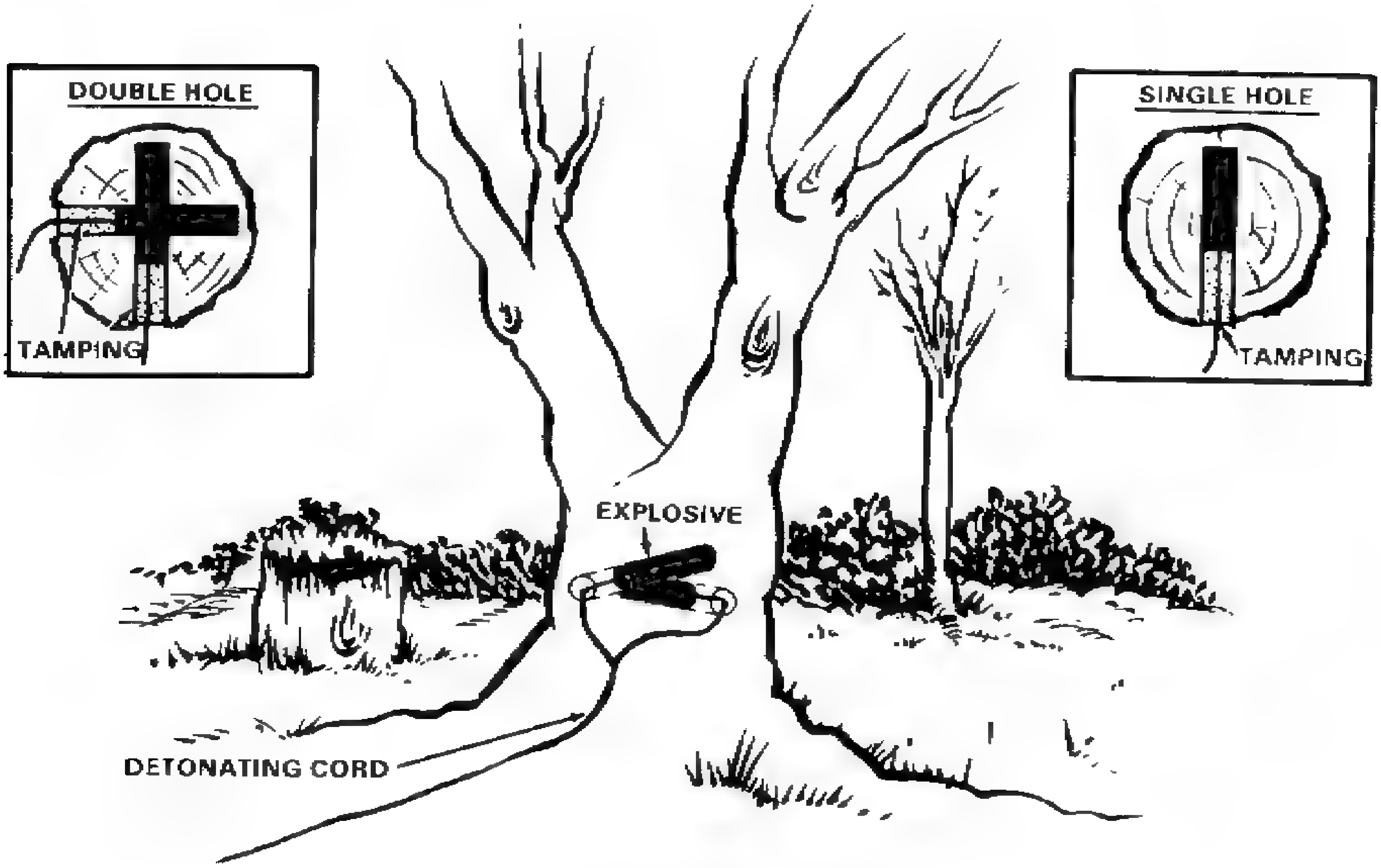


Figure 3-1. Internal timber-cutting charge

Problem—Determine the amount of TNT required to cut a round timber 30 inches in diameter using an untamped external charge.

Solution—Solve the problem presented as follows:

$$P = \frac{D^2}{40}$$

$$P = \frac{(30)^2}{40} = \frac{900}{40} = 22.50 \text{ or } 23 \text{ pounds of TNT per tree}$$

Concentrated external charge placement. To be most destructive, concentrated charges should be rectangular, 1 to 2 inches thick, and about twice as wide as they are high. Place charges as close as possible to the surface of the timber (Figure 3-2). Notch the tree to hold the explosive in place. If the tree or timber is not round and the direction of fall is of no concern, place the explosive

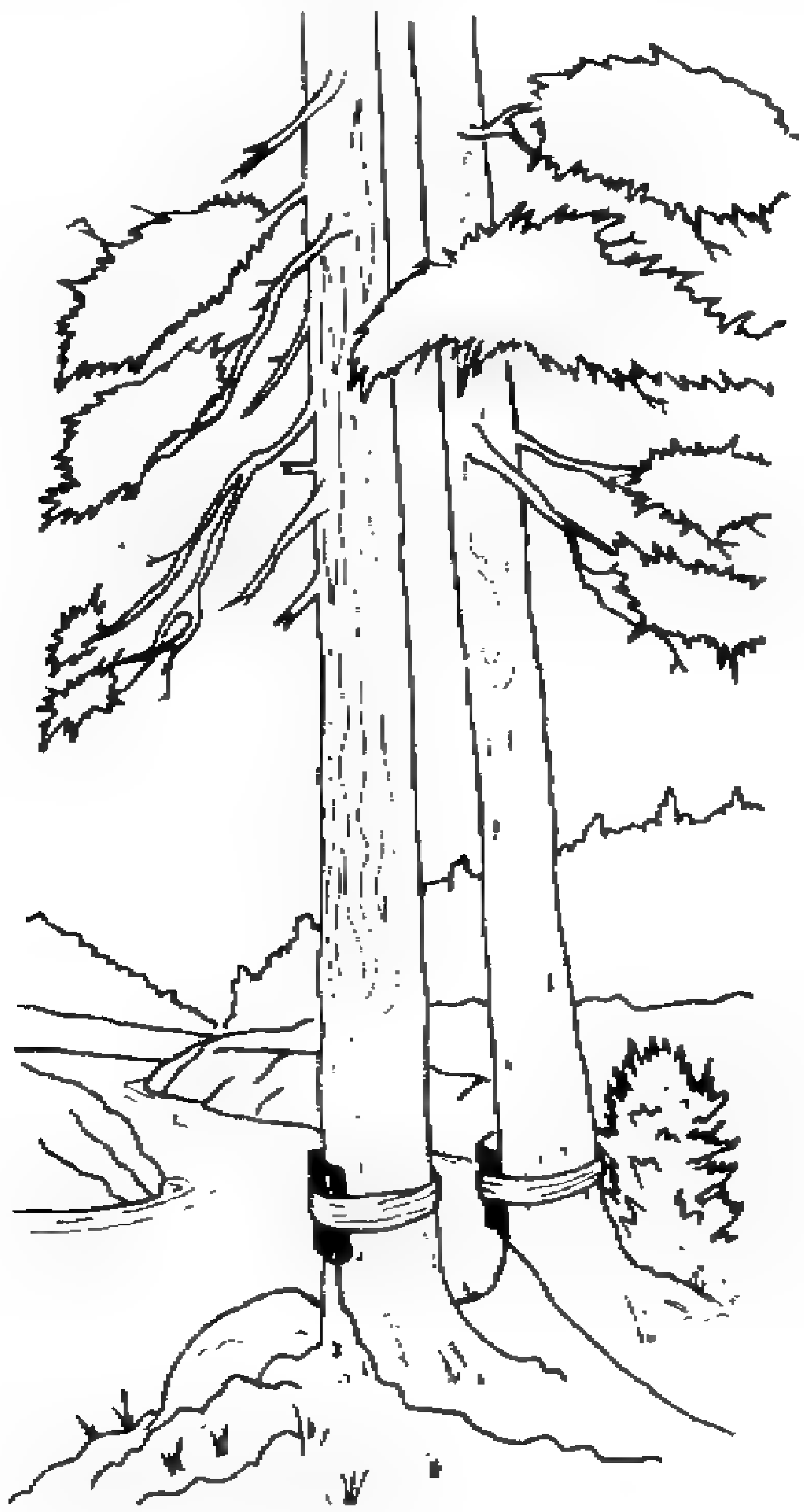


Figure 3-2. External timber-cutting charge

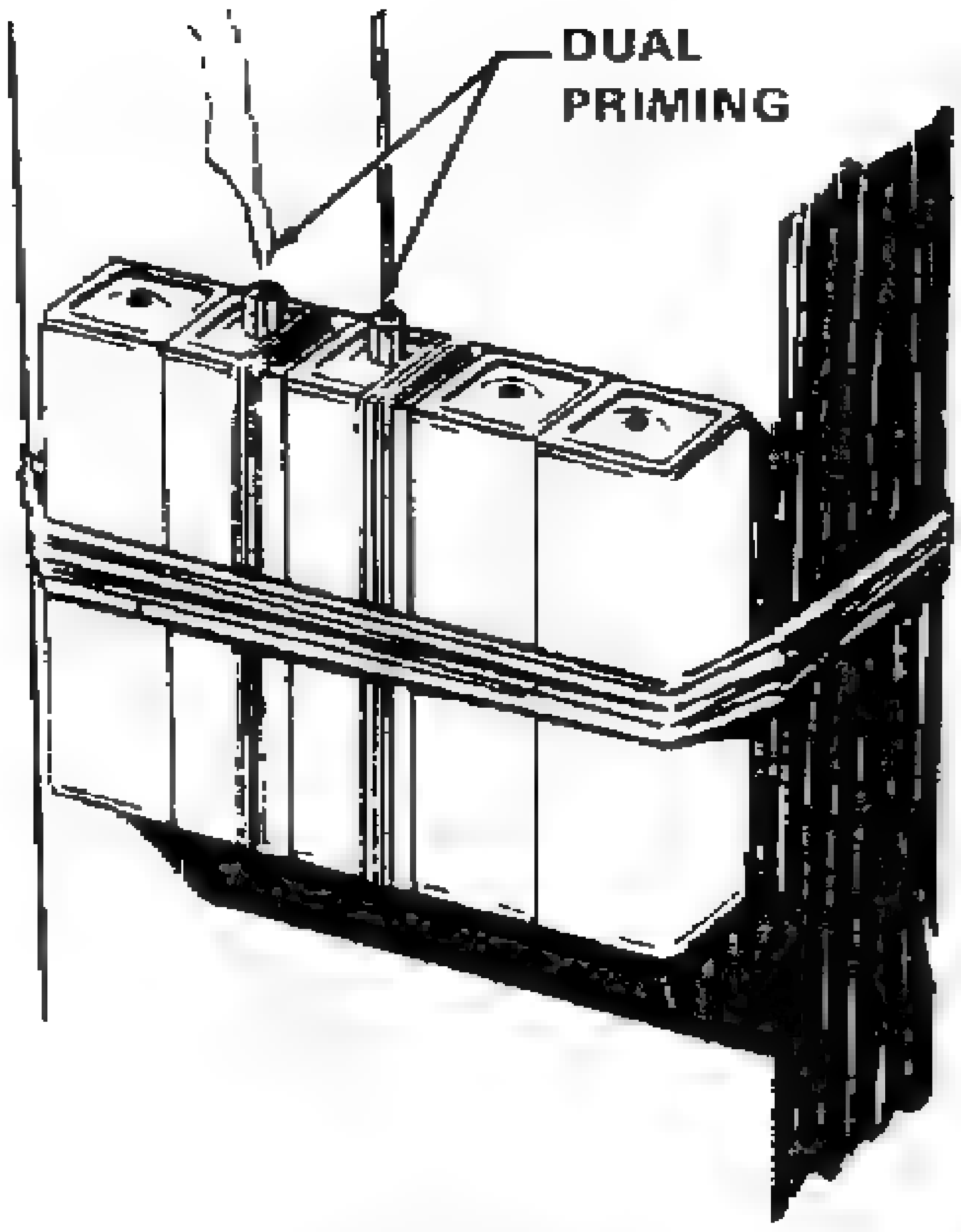


Figure 3-3. External cutting charge on rectangular timber

on the widest face so that the cut will be through the least thickness. The tree will fall toward the side where the explosive is placed, unless influenced by lean or wind. Place charges on rectangular or square dressed timber as shown in Figure 3-3.

Ring charge placement. The ring charge is a band of explosives completely circling the tree (Figure 3-4). The explosive band should be as wide as possible, at least ½ inch thick for small-diameter trees and 1 inch thick for medium- and large-diameter trees up to 30 inches. Use this technique when the direction of fall is not a consideration but the elimination of stumps is important as in, for instance, explosive clearing for a helicopter landing zone. Calculate the amount of explosive used by the external charge formula found in Equation (2).

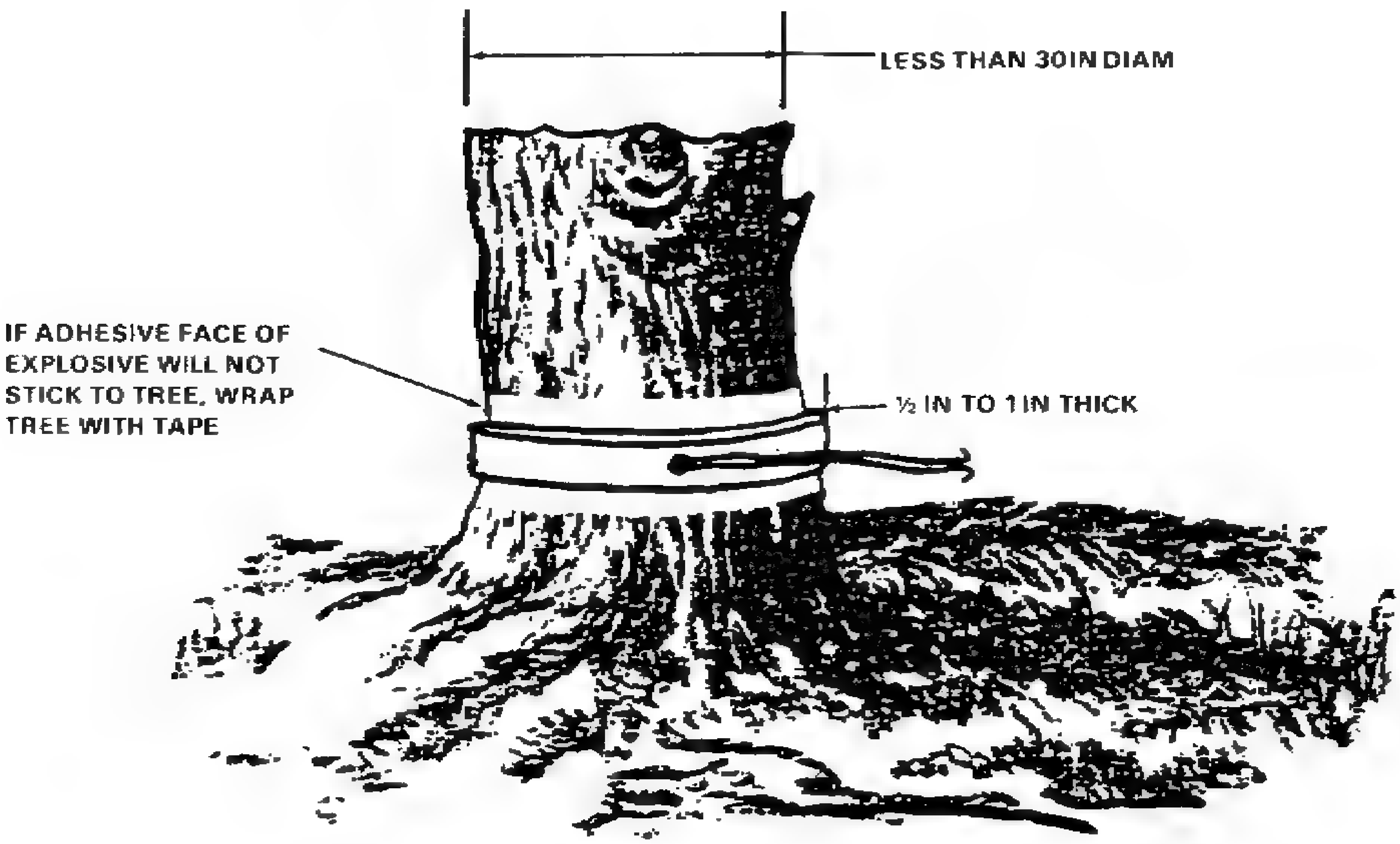


Figure 3-4. Timber-cutting ring charge

Abatis

When cutting trees and leaving them attached to the stumps to create an obstacle or abatis, use the formula

$$P = \frac{D^2}{50} \text{ or}$$

$$P = 0.002 \quad D^2 \qquad (3)$$

to compute the amount of TNT required for the test shot. The result of the test shot will determine how much explosive is required for subsequent shots.

Placement of abatis charges. Charges for making fallen-tree obstacles are placed as a concentrated external charge in the same way as for timber cutting with external charges except they are placed approximately 5 feet above ground level. The tree will fall toward the side where the explosive is placed unless influenced by lean or wind.

Special considerations. Observe the following rules to create an effective abatis:

- Make sure the obstacle is at least 75 meters deep.
- Make sure the individual trees are at least 24 inches in diameter.
- Space the row of trees selected for blasting far enough apart to let them fall without blocking other falling trees in the same row.
- Extend the felled trees at a 45-degree angle toward the enemy.
- Detonate the charges on the trees on one side of the road simultaneously. Follow the same procedure for trees on the opposite side of the road.
- Delay blasting of the second row of trees to allow time for the first row to fall so that the trees do not deflect one another from the desired direction of fall.
- To make obstacles harder to remove; mine, booby trap, entangle with barbed wire or concertina, and cover them by weapons fire.

STEEL-CUTTING CHARGES

Important Factors

In steel cutting charges, the type, size, and placement of the explosive are important for success. Confinement or tamping of the charge is rarely practical or possible. Formulas for computing the size of the charge vary with the type of steel such as structural or high-carbon. Placement of the charge in direct contact with the target is more important with steel than other materials.

Explosives used. Select steel-cutting charges for their cutting effect and adaptability to placement. Plastic explosive (C4) and sheet explosive (M118) are best because they have great cutting power. Plastic explosive (C4) can be cut and molded to fit tightly into the grooves and angles of the target, particularly structural steel, chains, and steel cables. The M112 block (C4) is more adaptable

because its size and shape are best for most steel-cutting charges, and it can be used without cutting or reshaping. Also, the M112 block adapts well to steel targets because of the adhesive compound on one face, which fixes it securely to the target. Sheet explosive (M118), because of its width (3 inches), thickness (¼ inch), and adhesive, is more desirable for some steel targets than M112 demolition blocks. Trinitrotoluene, on the other hand, is adequate, generally available, and cast into blocks that can be readily assembled and fixed, but not molded to the target.

Types of steel. Examples of structural steel are I-beams, wide-flange beams, channels, angle sections, structural tees, and steel plates used in building or bridge construction. These are the types of steel usually present in demolition projects.

Metal-working dies and rolls are made of high-carbon steel. Gears, shafts, tools, and plowshares usually are made of alloy steel. Chains and cables are often made from alloy steel. However, some are made of a high-carbon steel.

Cast iron is very brittle and breaks easily. Nickel-molybdenum steel cannot be cut easily by conventional steel-cutting charges. The jet from a shaped charge will penetrate it, but cutting will require multiple charges or a linear-shaped charge. Nickel-molybdenum steel shafts can be cut with the diamond charge in one shot. However, the saddle charge will not cut them. Therefore, nickel-molybdenum steel should be cut by some method other than explosives, such as thermite and acetylene or with electric cutting tools.

Size of Charge

Determine the amount of charge by the type and size of the steel and the kind of charge to be used.

Formulas for block explosive charges. Use the formulas presented in Equations (4) and (5) when block explosives such as TNT are used to cut steel sections.

Compute charges to cut I-beams, built-up girders, steel plates, columns, and other structural steel sections by using the following formula:

$$P = \frac{3}{8} A \text{ or } P = 0.375\, A \text{ where,}$$

P = pounds of TNT required per cut,

A = cross-section area, in square inches, of the steel member to be cut, and

$$\frac{3}{8} = 0.375 = \text{constant.} \qquad (4)$$

The following formula is recommended for the computation of block cutting charges for high-carbon or alloy steel, such as that found in machinery:

$P = D^2$ where,

P = pounds of TNT per cut, and

D = diameter or thickness, in inches, of section to be cut. (5)

Use the following formula for round steel bars, such as concrete reinforcing rods, where the size makes charge placement difficult or impossible, and for chains, cables, and steel rods with a diameter of less than 2 inches:

$P = D$ where,

P = pounds of TNT per cut, and

D = diameter, in inches, of section to be cut. (6)

Such steel, however, may be cut by the "rule of thumb"—

- For round bars up to 1 inch in diameter, use 1 pound TNT.
- For round bars over 1 inch and less than 2 inches in diameter, use 2 pounds of TNT.
- For round bars 2 inches and over in diameter, use the formula $P = \frac{3}{8} A$ found in Equation (4).

Another rule of thumb can be used when cutting railroad rail. The height of railroad rail is the critical dimension for calculating the amount of explosive required. Rails 5 inches or more in height can be cut with 1 pound of TNT. For rails less than 5 inches in height, ½ pound of TNT is adequate.

Problem—How much TNT is needed to cut one steel I-beam shown in Figure 3-5?

Solution—The solution is given in the figure.

CHARGE CALCULATION - TNT

$P = \frac{3}{8} A$
AREA OF FLANGE = 2 x ½ x 5 = 5 SQUARE INCHES
AREA OF WEB = ⅜ x 11 = 4⅛ SQUARE INCHES
TOTAL AREA (A) = 9⅛ SQUARE INCHES
$P = \frac{3}{8} A$
$P = \frac{3}{8} \times 9\frac{1}{8} = 3\frac{27}{64}$ POUNDS of TNT
USE 4 POUNDS OF TNT

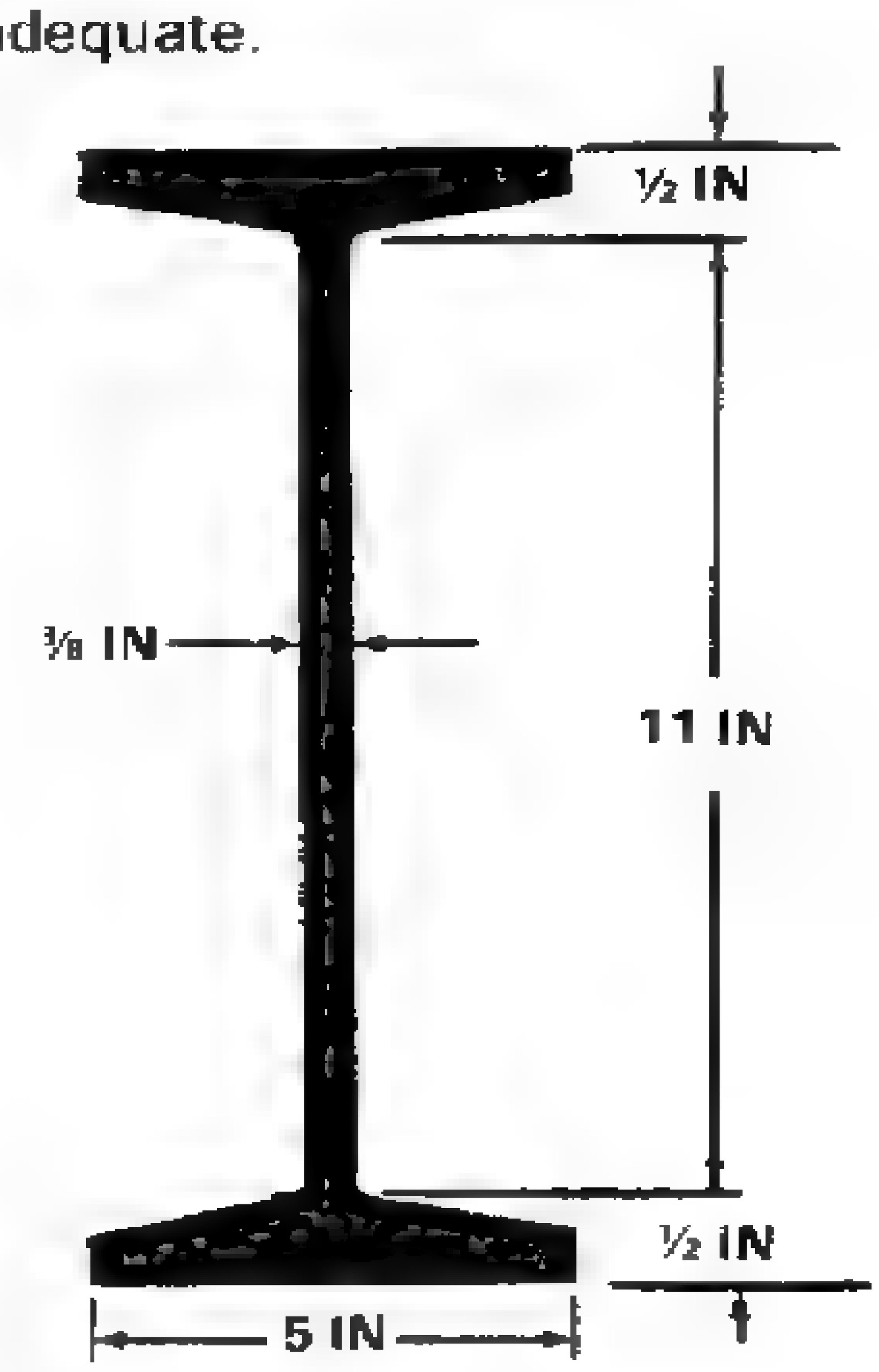


Figure 3-5. Calculation of charge to cut steel I-beam

$P = D$
P = POUNDS OF TNT REQUIRED, AND
D = DIAMETER IN INCHES OF STEEL CHAIN TO BE CUT
D = 1 INCH
P = 1 POUND OF TNT, IF BLOCK WILL BRIDGE LINK; IF NOT, USE TWO BLOCKS—ONE ON EACH SIDE OF LINK

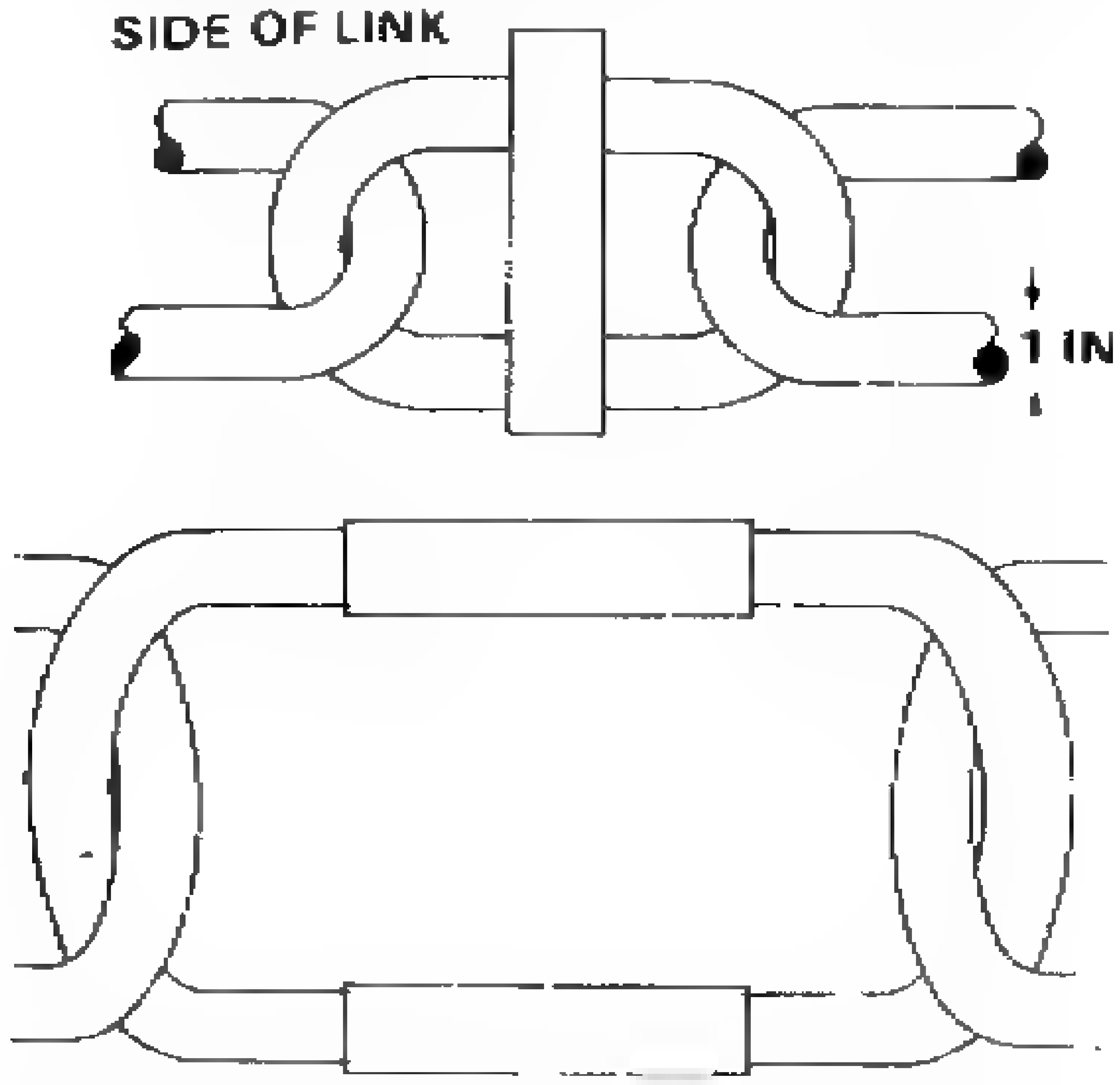


Figure 3-6. Calculation of charge to cut steel chain

Problem—How much TNT is needed to cut one steel chain in Figure 3-6?

Solution—The solution is given in the figure. Notice that the link is to be cut in two places (one cut on each side) to cause complete failure. If the explosive is long enough to bridge both sides of the link, or large enough to fit snugly between the two links, use one charge. If the explosive is not long enough to bridge both sides, use two separately primed charges.

A table can also be used to make calculations. Table 3-1 shows the correct weight of TNT necessary to cut steel sections of various dimensions calculated from the formula $P = \frac{3}{8} A$ given in Equation (4).

To use Table 3-1, follow these steps:

- Separately measure the rectangular sections of the members.
- Find the corresponding charge for each section by using the table.
- Total the charges for the sections.
- Use the next larger dimension if the dimension of these sections does not appear in the table.

Table 3-1. TNT needed to cut steel sections

Average thickness of section, in	Pounds of explosive* for rectangular steel sections of given dimensions																
	Height of section, in																
	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24
¼	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.5	1.7	1.9	2.1	2.3
⅜	0.3	0.5	0.6	0.7	0.9	1.1	1.2	1.3	1.4	1.6	1.7	2.0	2.3	2.6	2.8	3.1	3.4
½	0.4	0.6	0.8	1.0	1.2	1.4	1.5	1.7	1.9	2.1	2.3	2.7	3.0	3.4	3.8	4.2	4.5
⅝	0.5	0.7	1.0	1.2	1.4	1.7	1.9	2.2	2.4	2.7	2.9	3.3	3.8	4.3	4.7	5.2	5.7
¾	0.6	0.9	1.2	1.4	1.7	2.0	2.3	2.6	2.8	3.1	3.4	4.0	4.5	5.1	5.7	6.3	6.8
⅞	0.7	1.0	1.4	1.7	2.0	2.4	2.7	3.0	3.3	3.7	4.0	4.6	5.3	6.0	6.6	7.3	7.9
1	0.8	1.2	1.5	1.9	2.3	2.7	3.0	3.4	3.8	4.2	4.5	5.3	6.0	6.8	7.5	8.3	9.0

*TNT

Problem—How much TNT must be used to cut a steel I-beam using the information given in Figure 3-5 on page 3-11?

Solution—Solve the problem presented in Figure 3-5 as follows:

Charge for flanges—	Charge for web—
width = 5 inches thickness = ½ inch	height = 11 inches thickness = ⅜ inch
Charge from table = 1.0 pounds	Charge from table = 1.6 pounds

Total Charge: 2 flanges = 2 x 1.0 = 2.0 pounds
web = 1 x 1.6 = 1.6 pounds

$$\begin{array}{r} 2.0 \\ +\,1.6 \\ \hline \end{array}$$

Total = 3.6 pounds or, rounded up, 4 pounds of TNT.

Formulas for plastic or sheet explosive charges. When using plastic explosive (M112) charges or sheet explosive (M118 or M186) charges, which may be cut to fit the target with little or no air gap, use the formulas given in Equations (7), (8), and (9) (based upon the best charge configuration and contact with the target). These charge calculations are based on the dimensions of the target. With some practice, these charges may be calculated, prepared, and placed in less time than the charges calculated by the formulas listed for block explosive charges. These charges may also be prepared in advance for transportation to the site by wrapping them in aluminum foil or heavy paper. Remove the wrapper when the charge is attached to the target. When preparing these charges, do not mold the explosive, but cut it to the proper dimension. Molding the explosive will reduce its density and decrease its effectiveness.

If properly calculated and placed, the *ribbon charge* method cuts steel with less explosive than standard charges. It is effective on noncircular steel targets up to 3 inches thick (Figure 3-7). Although this charge is based on the use of C4 plastic explosive, use sheet explosives provided the ¼ inch by 3 inch by 12 inch sheets of flexible explosives are used intact and complete charges are at least ½ inch thick.

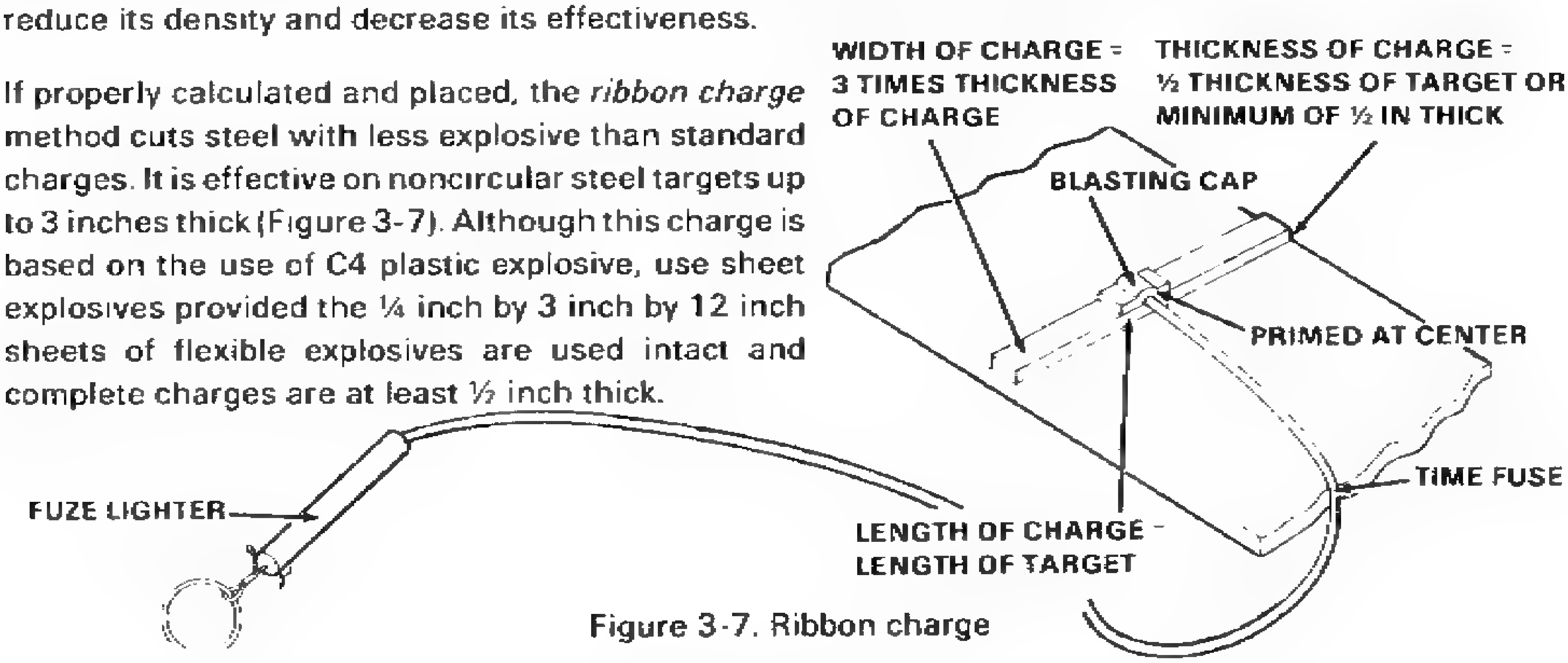


Figure 3-7. Ribbon charge

The effectiveness of the explosive depends on the width and thickness of the explosive. The thickness of the charge is half the thickness of the steel; however, THE CHARGE MUST BE AT LEAST ½ INCH THICK. The width of the charge is three times the thickness of the charge. The length of the charge should equal the length of the desired cut. Thus the formula is as follows:

Charge thickness = ½ times steel thickness

Charge width = 3 times the charge thickness

Charge length = length of desired cut (7)

Problem—Determine the thickness and width of a ribbon charge for cutting a steel plate 1 inch thick and 12 inches long.

Solution—The answer to the problem presented is as follows:

$$\text{Charge thickness} = \tfrac{1}{2}(1) = \tfrac{1}{2} \text{ inch}$$

$$\text{Charge width} = 3\left(\tfrac{1}{2}\right) = \frac{3}{2} = 1\tfrac{1}{2} \text{ inches}$$

$$\text{Charge length} = \text{length of target}$$

$$= 12 \text{ inches}$$

The charge is ½ inch thick, 1½ inches wide, and 12 inches long.

Detonate the ribbon charge from the center or from either end. When the charge thickness is small (less than ¾ inch), it may be necesary to place extra explosives around or over the blasting cap.

Use the ribbon charge computed by the formula in Equation (7) to cut structural steel sections (Figure 3-8). On wide-flange beams or I-beams less than 2 inches

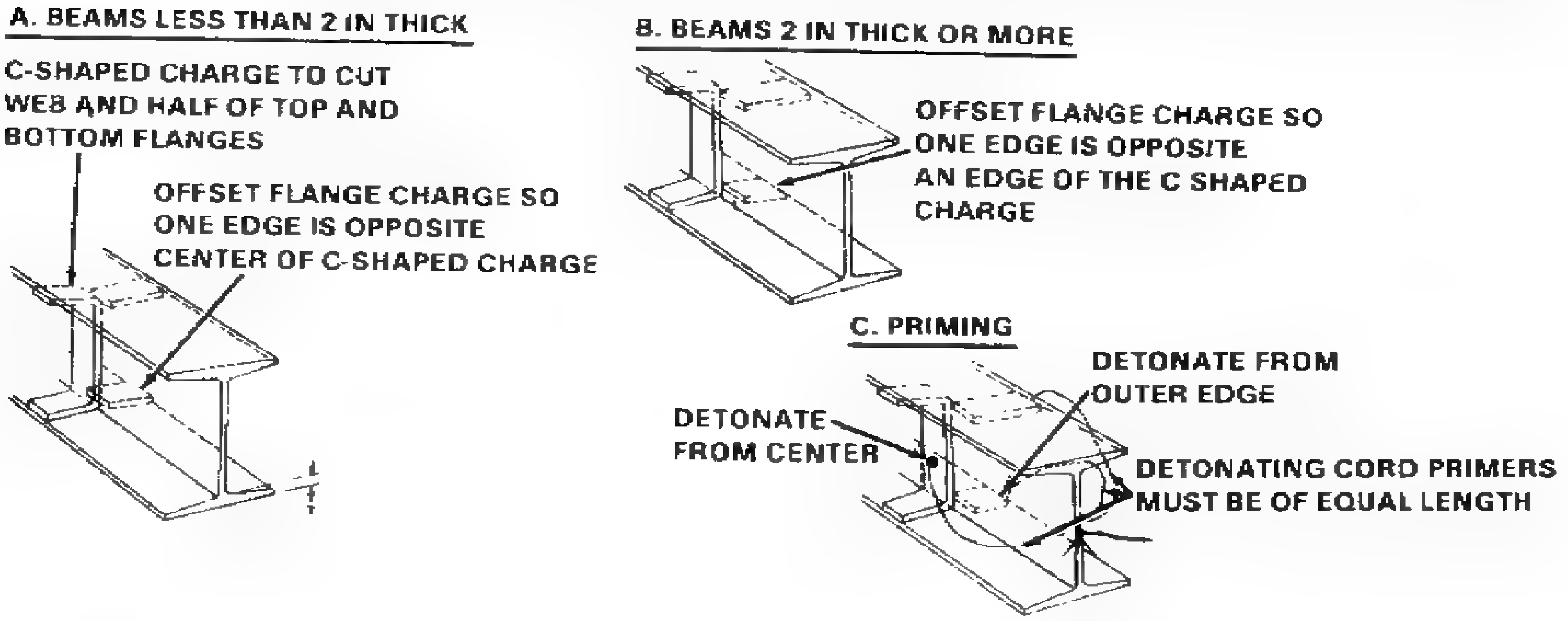


Figure 3-8. Placement of ribbon charges on structural steel sections

of steel thickness, place a C shaped charge on one side to cut the web and half the top and bottom flanges. The other sides of these flanges are cut by two offset ribbon charges placed so that one edge is opposite the center of the C-shaped charge as shown in Figure 3-8.

For beams with steel thickness of 2 inches and over, place the offset charges so one edge is opposite the edge of the C-shaped charge as shown in Figure 3-8. For acceptable results, the charges must be detonated at the **same instant**. This is done by priming the charges with three **exactly equal lengths** of detonating cords with blasting caps attached and placed in the charges as shown in Figure 3-8. Initiate the detonating cord primer by an electric or nonelectric system. Simultaneous detonation can also be done with M6 electric blasting caps wired in a series in the same circuit.

Use the cross-fracture method, which employs a *saddle charge*, to cut mild steel bars. This steel-cutting method uses the destructive effect of the end split or cross fracture formed in steel at the end of a charge, opposite the end where detonation was started. Use this technique on round, square, or rectangular mild steel bars up to 8 inches square or 8 inches in diameter. The cross-fracture method uses a charge cut in the shape of a triangle. This gives it the name saddle charge (Figure 3-9).

Compute the dimensions of the saddle charge from the dimensions of the target with the formula that follows:

Thickness of charge = 1 inch (thickness of M112 block of plastic explosive)

Base of charge = ½ circumference (or perimeter) of the target

Long axis of charge = circumference (or perimeter) of the target (8)

Problem—Using the formula given, determine the dimensions of a charge for cutting a shaft 18 inches in circumference

Solution—Solve the problem presented as follows:

Thickness = 1 inch

Base = ½ x 18 = 9 inches

Long axis = 18 inches

The charge is 9 inches at the base, 18 inches at the long axis, and 1 inch thick.

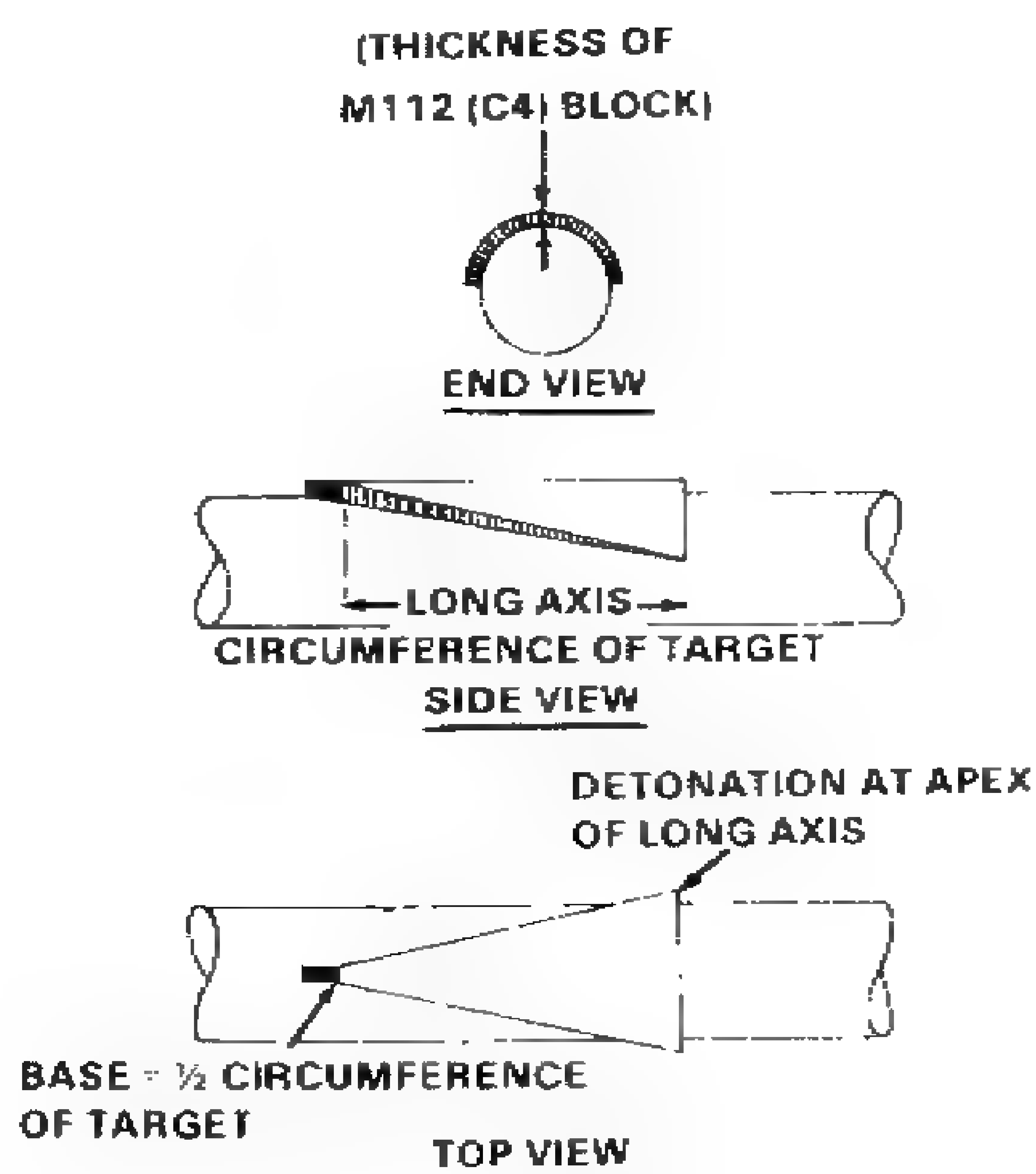


Figure 3-9. Saddle charge

Detonate the saddle charge by placing a military electric or nonelectric blasting cap at the apex of the long axis.

The long axis of the saddle charge should be parallel with the long axis of the target. Cut the charge to the correct shape and dimensions, and then mold it around the target. Take care to ensure that the charge is flush with the target. This can be done by taping the charge to the target.

The stress-wave method, which uses a *diamond-shaped charge,* is a steel-cutting technique that employs the destructive effect of two colliding shock waves. The shock waves are created from an explosive charge simultaneously detonated at opposite ends (Figure 3-10). Use this technique on high-carbon steel or steel-alloy bars up to 8 inches in diameter or square in cross section.

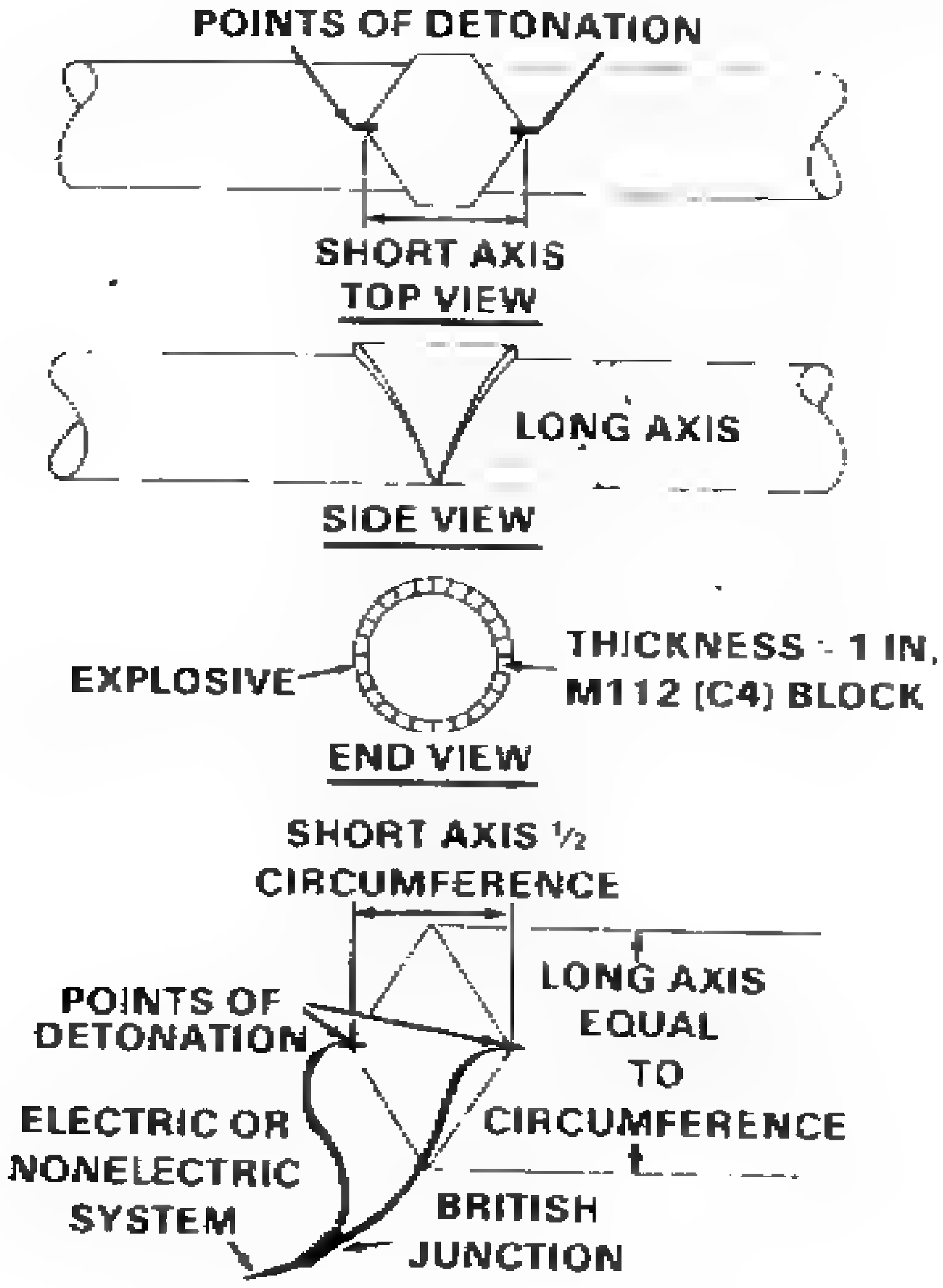


Figure 3-10. Diamond charge

Use the following formula to compute the dimensions of the diamond charge from the dimensions of the target:

Thickness of charge = 1 inch (thickness of M112 block).

Long axis of charge = circumference (or perimeter) of target.

Short axis of charge = ½ the circumference (or perimeter) of the target. (9)

Problem— Using the formula given, determine the size of a charge for cutting a steel-alloy shaft 15 inches in circumference.

Solution—Solve the problem presented as follows:

Thickness = 1 inch

Long axis = 15 inches

Short axis = ½ x 15 = 7½ inches

The charge is 15 inches at the long axis, 7½ inches at the short axis, and 1 inch thick.

Detonate a diamond charge **simultaneously** from both short axis ends. This can be done by priming with two pieces of detonating cord of the **same length** with nonelectric blasting caps crimped to the ends. Detonate the detonating cord primers with an electric or nonelectric blasting cap. Simultaneous detonation can also be done with M6 electric blasting caps wired in a series in the same circuit.

Wrap the explosive completely around the target so the ends of the long axis touch. It may be necessary to slightly increase the dimensions of the charge to do this. Tape the charge to the target if necessary to ensure complete contact with the target.

Charge Placement

Steel sections. The size and type of a steel section will determine the placement of the explosive charge. Cut extended sections by placing the explosive on one side of the section completely along the proposed line of rupture. In some steel trusses with individual members fabricated from two or more primary sections (such as angle irons or bars separated by spacer washers or gusset plates), place the charge with its opposing portions offset the same distance as the thickness of the section being cut to produce a shearing action. Heavier I-beams, wide-flange beams, and columns can also require auxiliary charges placed on the outside of the flanges. Ensure that opposing charges are **never** directly opposite each other because this tends to neutralize the explosive effect.

Rods, chains, and cables. Block explosives are not recommended for cutting steel rods, chains, and cables if plastic explosives are available.

Steel members and railroad rails. Charge placements for cutting these are found in Figure 3-11.

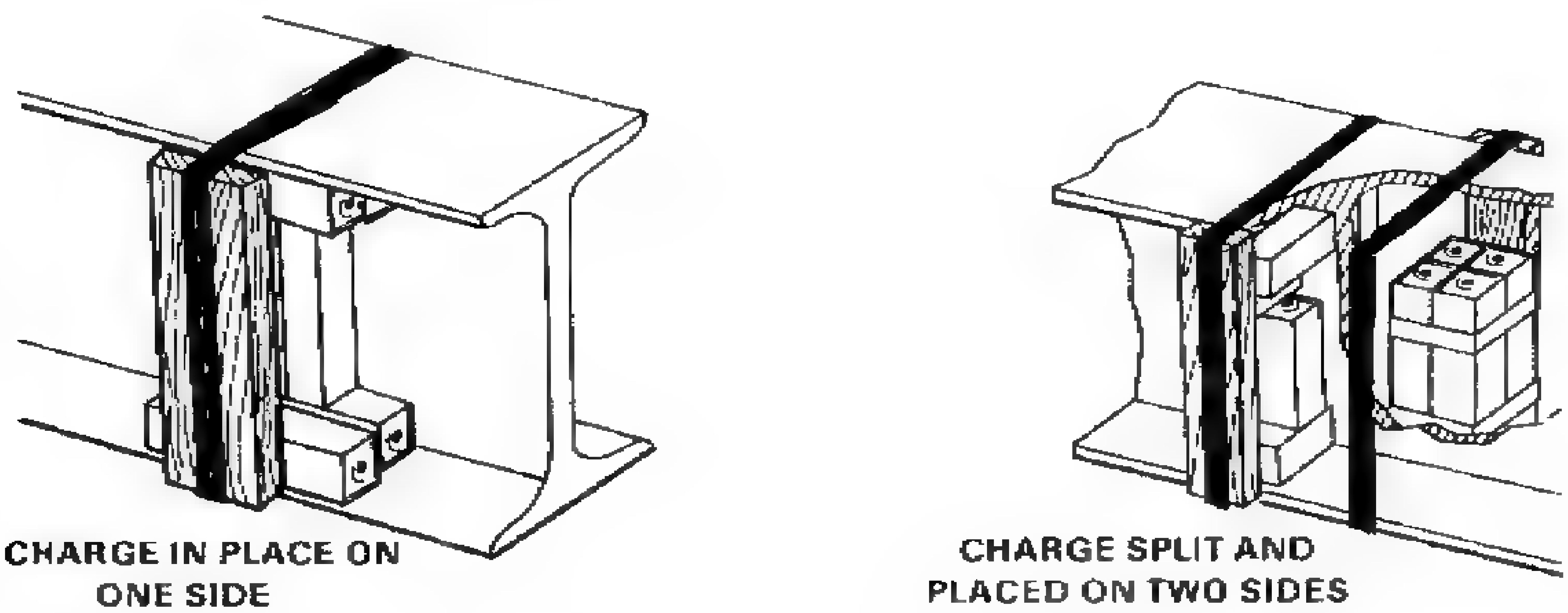


Figure 3-11. Placement of charges on steel members

Built-up members. Built-up members frequently have an irregular shape, making it difficult to obtain close contact between the explosive charge and all of the surface. If it is impractical to distribute the charge properly to obtain close contact, increase the amount of explosive

Irregular steel shapes. Composition C4 is a good explosive for cutting irregular steel shapes because it is easily molded or pressed into place to give maximum contact. The M112 block and the M118 sheet explosive have an adhesive coating on one side, making placement easier.

Security of placement. Tie, tape, and wedge all explosives (except adhesive types) in place unless they rest on horizontal surfaces and are not in danger of being jarred out of place.

Precautions. Place the steel-cutting charge on the same side as the firing party because explosive charges throw steel fragments (missiles) long distances at high velocities.

BREACHING CHARGES

Critical Factors and Computation

Use breaching charges to destroy concrete slab bridges, bridge beams, bridge piers, bridge abutments, and permanent field fortifications. The size, shape, placement, and tamping or confinement of the breaching charges are critical factors. The size and confinement of the explosive are more important because of the strength and bulk of the material to be breached. High explosive breaching charges detonated in or against a target must produce and transmit enough energy to the target to crater and spall the material. The metal reinforcing bars in reinforced concrete cannot be cut by breaching charges. If it is necessary to remove or cut the reinforcement, use the steel-cutting formula given in Equation (4) after the concrete is breached.

Calculation formula. Calculate the size of a charge required to breach concrete, masonry, rock, or similar material by using the formula that follows. Determine the charge size, for any explosive, by adjusting the value of P.

P = R^3KC where,

P = pounds of TNT required,

R = breaching radius (in feet),

K = material factor, given in Table 3-2, which reflects the strength, hardness, and mass of the material to be demolished, and

C = a tamping factor, given in Figure 3-12, which depends on the location and tamping of the charge. (10)

Breaching radius R. The breaching radius R is the distance in feet from an explosive in which all material is displaced or destroyed. The breaching radius for external charges is the thickness of the mass to be breached. The breaching radius for internal charges is one half the thickness of the mass to be breached if the charge is placed midway in the mass. If holes are drilled less than halfway into the mass, the breaching radius becomes the longer distance from the center of the charge to the outside of the mass. For example, if a 4-foot wall is to be breached by an internal charge placed 1 foot into the wall, the breaching radius is 3 feet. If it is to be breached by a centered internal charge, the breaching radius is 2 feet. The breaching radius is 4 feet if an external charge is used. Values of R are rounded to the next higher ½ foot for external charges and next higher ¼ foot for internal charges.

Material factor K. The K factor is the strength and hardness of the material to be breached. Table 3-2 gives values for the K factor for various types and thicknesses of material. If the type of material in the object is questionable, it is always assumed to be the stronger type. Concrete is assumed to be reinforced unless stated otherwise. Masonry is assumed to be first-class unless stated otherwise.

Table 3-2. Values of *K* (material factor) for breaching charges

Material	R	K
Earth	All Values	0.07
Poor masonry, shale, hardpan, good timber and earth construction	Less than 1.5 m (5 ft)	0.32
	1.5 m (5 ft) or more	0.29
Good masonry, concrete block, rock	.3 m (l ft) or less	0.88
	over .3 m (1 ft) to less than .9 m (3 ft)	0.48
	.9 m (3 ft) to less than 1.5 m (5 ft)	0.40
	1.5 m (5 ft) to less than 2.1 m (7 ft)	0 32
	2.1 m (7 ft) or more	0 27
Dense concrete, first class masonry	.3 m (1 ft) or less	1.14
	over .3 m (1 ft) to less than .9 m (3 ft)	0.62
	.9 m (3 ft) to less than 1.5 m (5 ft)	0.52
	1.5 m (5 ft) to less than 2.1 m (7 ft)	0.41
	2 1 m (7 ft) or more	0 35
Reinforced concrete (concrete only; will not cut reinforcing steel)	.3 m (1 ft) or less	1.76
	over 3 m (1 ft) to less than .9 m (3 ft)	0 96
	.9 m (3 ft) to less than 1.5 m (5 ft)	0.80
	1.5 m (5 ft) to less than 2.1 m (7 ft)	0.63
	2.1 m (7 ft) or more	0.54

Tamping factor C. The value of the tamping factor *C* depends on the location and the tamping of the charge. Figure 3-12 illustrates methods for placing charges and gives values of *C* to be used in the breaching formula with both tamped and untamped charges. In selecting a value of *C* from Figure 3-12, do not consider a tamped charge with a solid material (such as sand or earth) fully tamped unless it is covered to a depth equal to or greater than the breaching radius.

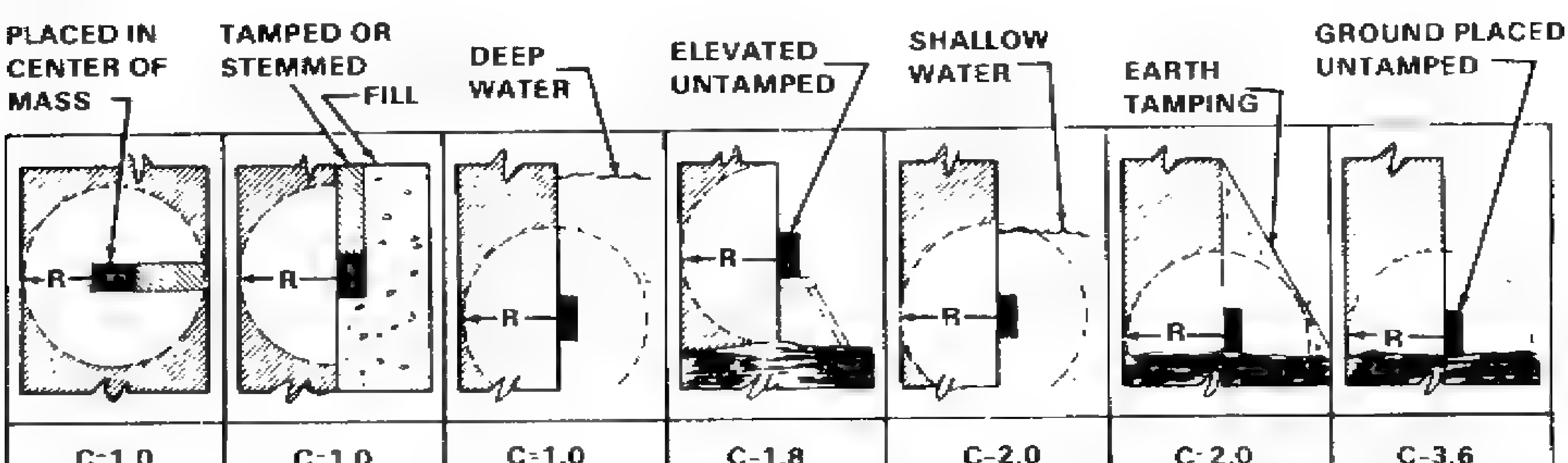


Figure 3-12. Values of *C*, the tamping factor, for breaching charges

Breach of reinforced-concrete target. Figure 3-13 gives the amount of TNT required to breach reinforced-concrete targets. The amounts of TNT in the matrix are calculated from the formula $P = R^3KC$, found in Equation (10). To use the figure, perform the following steps:

- Measure the thickness of the concrete.
- Decide how the charge will be placed against the target.

Compare the method of placement with the diagrams at the top of the figure. If there is a question of which column to use, always use the column that lists the **greatest** amount of explosive.

- Use the *relative effectiveness (RE)* factor highlighted in Table 1-2 on page 1-8 for explosives other than TNT.

For example, using Figure 3-13, calculate the amount of TNT required to breach a reinforced-concrete wall 7 feet thick with an untamped charge placed at a distance 7 feet above the ground. From the figure, the required amount of TNT is 334 pounds.

Breach of materials other than reinforced concrete. Figure 3-13 can also be used to calculate breaching charges for obstacles of material other than reinforced concrete by multiplying the value obtained from Figure 3-13 by the proper conversion factor given in Table 3-3. Perform the following steps:

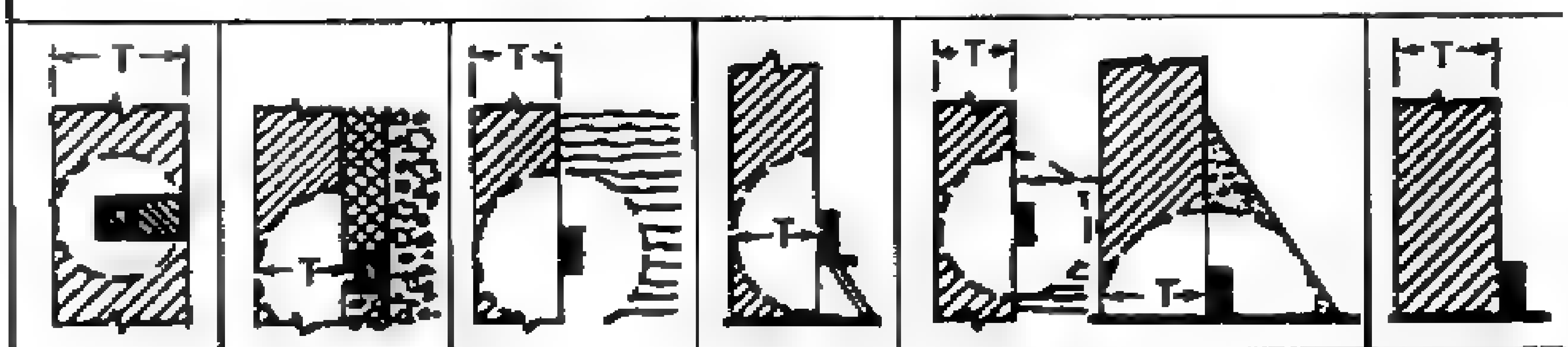
- Determine the type of material in the object. If in doubt, assume the material to be of the stronger type.
- Determine the amount of explosive that would be required if the object were made of reinforced concrete using Figure 3-13.
- Determine the appropriate conversion factor using Table 3-3.
- Multiply the number of pounds of explosive by the conversion factor.

For example, using Figure 3-13 and Table 3-3, determine the amount of TNT required to breach an ordinary masonry pier 4½ feet thick with an untamped charge placed 4 feet below the waterline. If the pier were made of reinforced concrete, use Figure 3-13 to determine that 146 pounds of TNT would be required to breach it. The conversion factor, found in Table 3-3, is 0.5. Therefore, the equation should read 146 multiplied by 0.5 equals 73. The answer for the amount of TNT required to breach the pier is 73 pounds.

Number of Charges and Placement

Placement. In the demolition of piers and walls, the positions for the placement of explosive charges are limited. Unless a demolition chamber is available, place the charge (or charges) against one face of the target. A charge placed above ground level is more effective than one placed directly on the ground. When several charges are required to destroy a pier, slab, or wall, and elevated charges

are desired, they are distributed equally at no less than one breaching radius high from the base of the object to be demolished. In this way, the best use is made of the shock wave of the blast. Place breaching charges so that there is a free reflection surface on the opposite side of the target. This free reflection surface is necessary for spalling to occur. If time permits, tamp all charges thoroughly with damp soil or filled sandbags. Tamping must be equal to or

Thickness of concrete	METHODS OF PLACEMENT				
					
	C-1.0		C-1.8	C-2.0	C-3.6
Feet	All explosives	Pounds of TNT			
2	2	8	14	16	28
2½	2	15	27	30	54
3	4	22	39	44	78
3½	6	35	62	69	124
4	8	52	93	103	185
4½	11	73	132	146	263
5	15	79	142	158	284
5½	20	105	189	210	378
6	22	136	245	273	490
6½	28	173	312	346	623
7	35	186	334	371	667
7½	43	228	410	456	821
8	52	277	498	553	996

Use the matrix above to -

- Measure thickness of concrete
- Determine method of placement
- Note TNT required according to method of placement
- If using explosive other than TNT, divide by relative effectiveness (RE) factor for all methods of emplacement except internal

Figure 3-13. Breaching charges for reinforced concrete

Table 3-3. Conversion factors for material other than reinforced concrete

Earth	Ordinary masonry, hardpan, shale, ordinary concrete, rock, good timber and earth construction	Dense concrete, first-class masonry
0.1	0.5	0.7

greater than the breaching radius. For piers, slabs, or walls partially submerged in water, place charges equal to or greater than the breaching radius below the waterline if possible (Figure 3-12 on page 3-19).

Charge configuration. For maximum effectiveness, place the explosive charge in the shape of a flat square with the flat side to the target. The thickness of the charge depends on the amount of explosive, and is given in Table 3-4.

Table 3-4. Thickness of breaching charge*

Amount of explosive	Thickness of charge
Less than 5 lb	1 in
5 lb to less than 40 lb	2 in
40 lb to less than 300 lb	4 in
300 lb or more	8 in

*These are approximate values

Number of charges. The number of charges required to demolish a pier, slab, or wall is calculated by the following formula:

$N = \frac{W}{2R}$ where,

N = number of charges,

W = width of pier, slab, or wall, in feet,

R = breaching radius (in feet)

2 = constant (11)

If the calculated value of N is 0 to less than 1¼, use one charge; if it is 1¼ to less than 2½, use two charges; if it is 2½ or more, round to nearest whole number. In breaching concrete beam bridges, breach each beam individually. The first charge is placed R distance in from one side of the target. The remainder of the charges are spaced at a distance of $2R$ apart.

Counterforce Charge

Use of counterforce charge. This special breaching technique is effective against comparatively small cubical or columnar concrete and masonry objects 4 feet or less in thickness and width. It is not effective against walls, piers, or long obstacles. The obstacle must also have at least three free faces or be freestanding. If constructed of plastic explosives, properly placed and detonated, counterforce charges produce excellent results with a relatively small amount of explosive. Their effectiveness results from the simultaneous detonation of two

charges placed directly opposite each other and as near the center of the target as possible (Figure 3-14).

Charge calculation. Compute the amount of plastic explosive based on the diameter or thickness of the target in feet. The amount of plastic explosive equals 1½ times the thickness of the target in feet (1½ pounds of explosive per foot). Round fractional measurements to the next higher ½ foot before multiplying. For example, a concrete target measuring 3 feet 9 inches thick requires 6 pounds (1½ x 4) of plastic explosive (Composition C4).

Preparation and emplacement of charges. Divide the amount of plastic explosive in half to make two equal charges. Place the two charges directly opposite each other. This method requires accessibility to both sides of the target so the charges can be placed flush against the respective target sides.

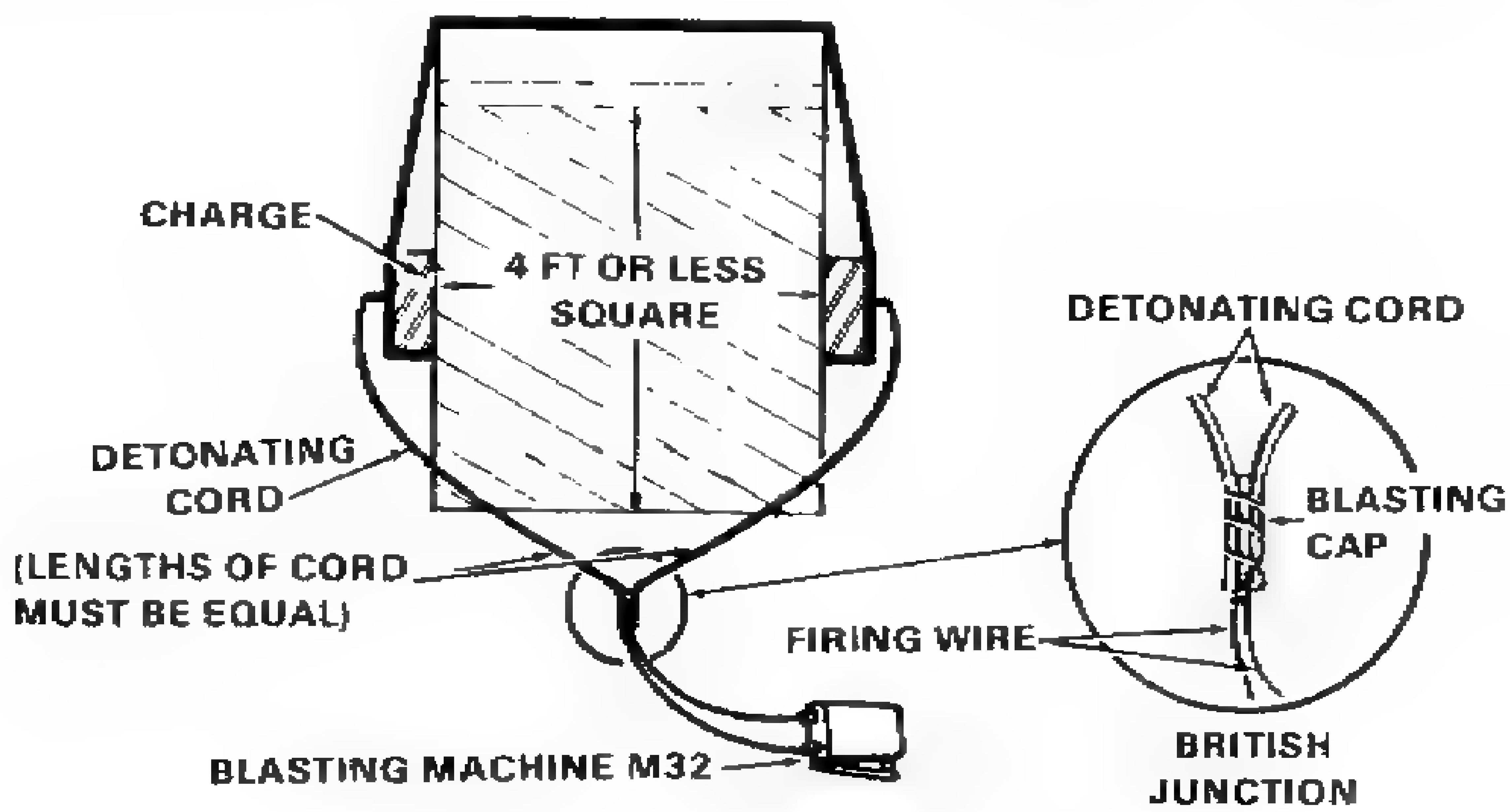


Figure 3-14. Counterforce charge

Priming. The simultaneous detonation of both charges is required for the best results. Crimp nonelectric blasting caps to equal lengths of the detonating cord. Prime both charges at the center rear point. Then, form a V with the free ends of the detonating cord, and attach an electric or nonelectric cap for firing. Simultaneous detonation can also be done with M6 electric blasting caps wired in series in the same circuit.

CRATERING AND DITCHING CHARGES

Critical Factors

Sizes. To be effective obstacles, road craters must be too wide for spanning by track-laying vehicles and too deep and steep-sided for any vehicle to pass through them. Blasted road craters will not stop modern tanks indefinitely. Repeated attempts by the tank to traverse the crater will pull loose soil from the slopes of the crater into the bottom, reducing both the depth of the crater and the

angle of the slopes. Road craters are effective antitank obstacles if the tank requires three or more passes to traverse the crater, thereby providing enough time for antitank weapons to stop the tank. Road craters must also be large enough to tie into natural or constructed obstacles at each end Improve the effectiveness of blasted road craters by placing log hurdles on either side, digging the face on the friendly side vertically, mining the site with antitank and antipersonnel mines, filling the crater with water, or other means that will delay enemy armor. Road craters in defiles or road cuts where the enemy tank must approach the crater head on should be cut at a 45-degree angle across the gap to enhance the tank's tendency to slip sideways and ride off its track when trying to negotiate an angled cut.

Explosives. All military explosives can be used for blasting antitank craters. Use a special 40-pound cratering charge of ammonium nitrate issued in a waterproof metal container, when available.

Placement of charges. In deliberate cratering, bore holes to specific depths and space according to computation by the formula, as described in Equation (12). In ditching, make test shots and increase the diameter and depth as required.

Confinement of charges. Place charges at cratering sites and antitank sites in boreholes and properly stem them. Tamp the charges at culvert sites with sandbags.

Breach of hard-surfaced pavements for cratering charges. Breach hard-surfaced pavement of roads and airfields so holes can be dug for cratering charges. This can be done effectively by exploding tamped charges on the pavement surface. Use a 1-pound charge of explosive for each 2 inches of pavement thickness. Tamp the charges with material twice as thick as the pavement. The pavement can also be breached by charges placed in boreholes drilled or blasted through it. (A shaped charge readily blasts a small-diameter borehole through the pavement and into the subgrade.) **Do not** breach concrete at an expansion joint because the concrete will shatter irregularly.

Boreholes for cratering charges. Dig boreholes for cratering charges by using motorized posthole augers or hand posthole augers or diggers. Make boreholes by using the earth rod kit, Chapter 1, Explosive Earth Rod Kit, or a mechanically driven pin and widen with the detonating cord wick, Chapter 3, Springing Charges.

Boreholes made with shaped charges. Use standard shaped charges to blast boreholes in paved and unpaved surfaces for rapid road-cratering with explosives. The 15-pound M2A3 and the M2A4 shaped charges detonated at a 3½-foot standoff and the 40-pound M3A1 shaped charge detonated at a 5-foot standoff will blast boreholes up to 9 feet deep with a 7-inch or larger diameter in both reinforced-concrete pavements and gravel-surfaced roads. For maximum effectiveness, use M3A1 shaped charges to blast boreholes in thick reinforced-concrete pavements laid on dense high-strength base courses. Use the M2A3

and the M2A4 shaped charges to effectively blast cratering charge boreholes in reinforced-concrete pavement of less than 6-inch thickness laid on thin base courses or to blast boreholes in unpaved roads. Most military explosives, including the cratering charges, can be loaded directly into boreholes made by the M3A1, M2A3, and the M2A4 shaped charges. Shaped charges do not always produce open boreholes that can be loaded directly with 7-inch diameter cratering charges without removing some earth or widening narrow areas. Widen deep boreholes with narrow diameters by knocking material from the constricted areas with a pole or rod or by breaking off the shattered surface concrete with a pick or crowbar. For road cratering on asphalt or concrete-surfaced roadways, blasting the boreholes with shaped charges will speed up the cratering task by eliminating the need to breach the pavement first with explosive charges (Table 3-5).

Table 3-5. Size of boreholes made by shaped charges

Material	Specifications	M2A3/M2A4 shaped charge 15 lb	M3A1 shaped charge 40 lb
Armor plate	Penetration	12 in	At least 20 in
	Average diameter of hole	1½ in	2½ in
Reinforced concrete	Maximum wall thickness that can be perforated	36 in	60 in
	Depth of penetration in thick walls	30 in	60 in
	Average diameter of hole	2¾ in	3½ in
	Minimum diameter of hole	2 in	2 in
10-in concrete pavement with 21-in rock base course	Optimum standoff	42 in	60 in
	Minimum depth of penetration	44 in	71 in
	Maximum depth of penetration	91 in	109 in
	Minimum diameter of hole	1¾ in	6¾ in
3-in concrete pavement with 24-in rock base course	Optimum standoff	42 in	
	Minimum depth of penetration	38 in	
	Maximum depth of penetration	90 in	
	Minimum diameter of hole	3¾ in	
Permafrost	Depth of hole with 30-in standoff	72 in	
	Depth of hole with 42-in standoff	60 in	
	Diameter of hole with 30-in standoff	1½ in to 6 in	
	Depth of hole with 50-in standoff		72 in
	Diameter of hole with 50-in standoff		5 in to 8 in
	Diameter of hole with normal standoff	4 in to 26-30 in	7 in to 26 30 in
Ice	Depth with 42-in standoff	7 ft	12 ft
	Diameter with 42-in standoff	3½ in	6 in
Soil	Depth with 30-in standoff	7 ft	
	Diameter with 30-in standoff	7 in	
	Depth with 48-in standoff		7 ft
	Diameter with 48 in standoff		14½ in
Graveled roads	Depth with 40 in standoff	7 ft	
	Diameter with 40-in standoff	7 in	
	Depth with 60-in standoff		9 ft
	Diameter with 60-in standoff		7 in

Hasty Road Crater

Effects of the hasty road crater. This method takes the least amount of time for construction, based upon the number and the depth of boreholes, but produces the least effective barrier because of its depth and shape (Figure 3-15). The method described forms a V-shaped crater about 6 to 7 feet deep and 20 to 25 feet wide, extending approximately 8 feet beyond each end borehole. The sides have slopes of 25 to 35 degrees. Modern US combat tanks require an average of four passes to cross hasty road craters. Craters formed by boreholes less than 5 feet deep and loaded with charges less than 50 pounds are useless against tanks. A satisfactory method of creating a hasty road crater follows:

- Dig all boreholes to the same depth (recommend at least 5 feet). Space the holes 5 feet apart center-to-center across the road.

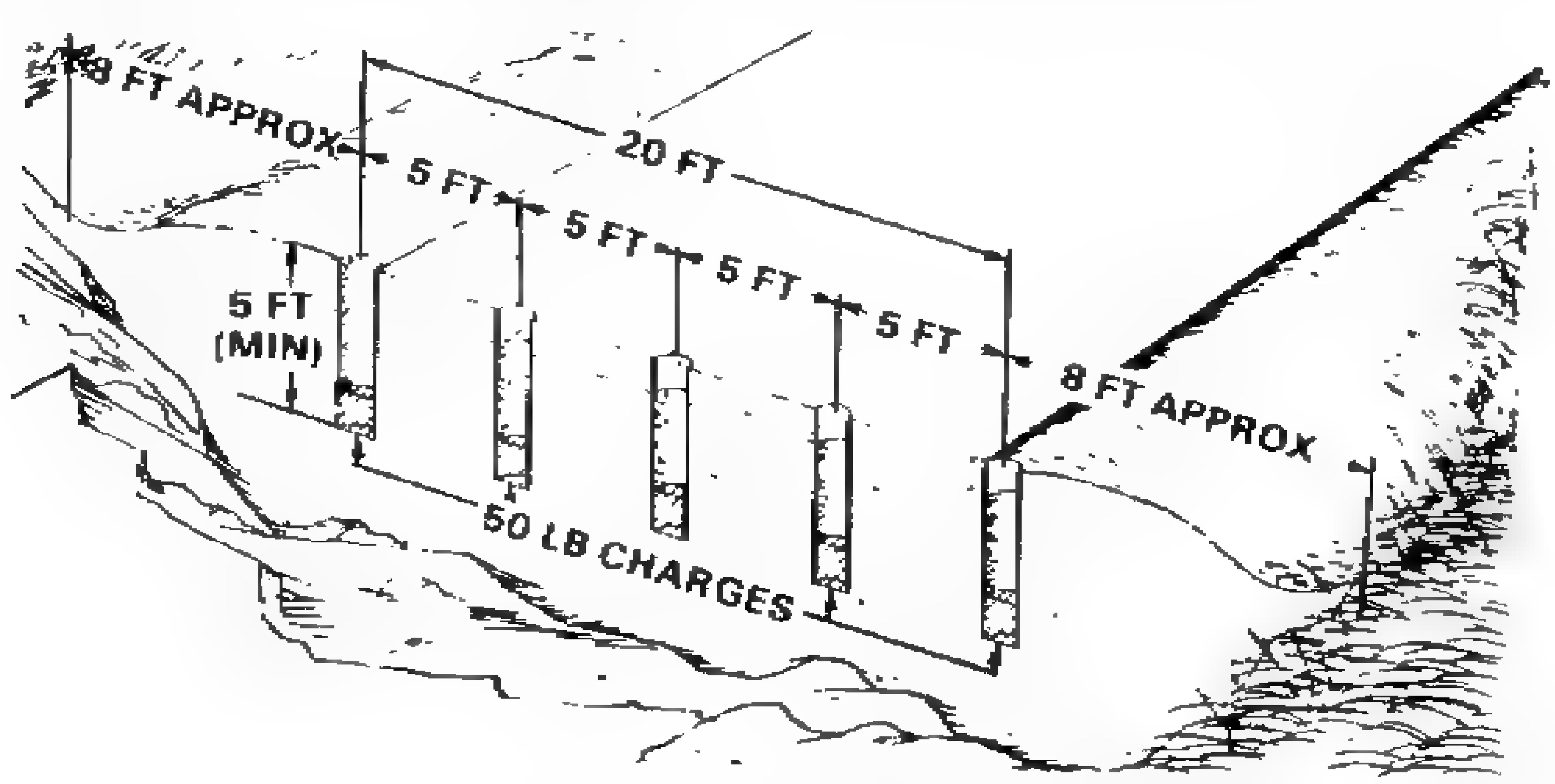
Use the following formula to compute the number of holes:

$$N = \frac{L - 16}{5} + 1, \text{ where,}$$

L = length of crater (in feet) measured across the area to be cut. Round up any fractional number of holes to the next higher number. (12)

- Load the boreholes with 10 pounds of explosive per foot of depth.
- Prime all charges with detonating cord, and connect them to fire simultaneously. Prime underground charges with detonating cord branch lines. Use a dual firing system.
- Stem all boreholes with suitable material.

Dual priming the charge. Place a 1-pound priming charge on the side of the charge for dual priming if the standard cratering charge is used. Supplement each charge with additional explosive to obtain 10 pounds of explosive per foot of borehole for hasty cratering if standard cratering charges are used.



NOTE: Prior to emplacement, inspect each cratering charge carefully for possible water damage

Figure 3-15. Charge placement for hasty road crater

Deliberate Road Crater

Effects of deliberate road crater. This method, shown in Figure 3-16, produces more effective road craters than the hasty method. Modern US tanks must make an average of eight passes to cross them. The crater produced is V-shaped, approximately 7 to 8 feet deep, 25 to 30 feet wide, with side slopes approximately 30 to 37 degrees. The crater extends approximately 8 feet beyond the end holes.

Charges are placed by boring the holes 5 feet apart, center-to-center, in a line across the area to be cut. The end holes are 7 feet deep, and the others are alternately 5 feet and 7 feet deep. Compute the number of holes using Equation (12). Do not place two 5-foot holes next to each other. If one must be a 5-foot hole, place the resulting two adjacent 7-foot holes close to the middle along the line.

Place 80 pounds of explosive in the 7-foot holes and 40 pounds of explosive in the 5-foot holes. Stem all holes with suitable material.

Prime charges for deliberate cratering. Prime the charges for deliberate cratering by dual priming all holes. For the 7-foot holes, this can be done by independently priming each of the two cratering charges, if used. For the 5-foot holes, place a 1-pound priming charge on the side of the charge for dual priming if the standard cratering charge is used.

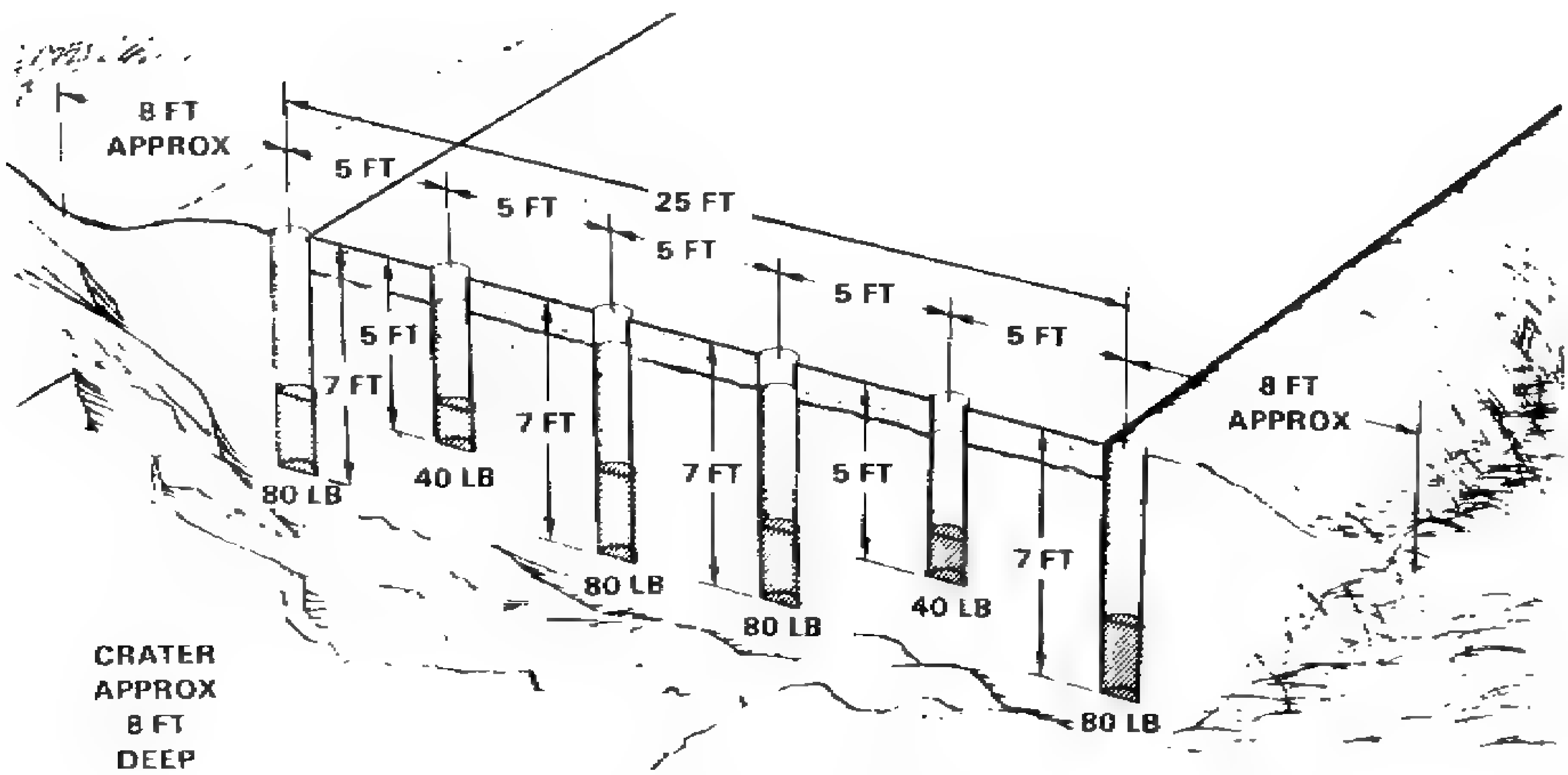
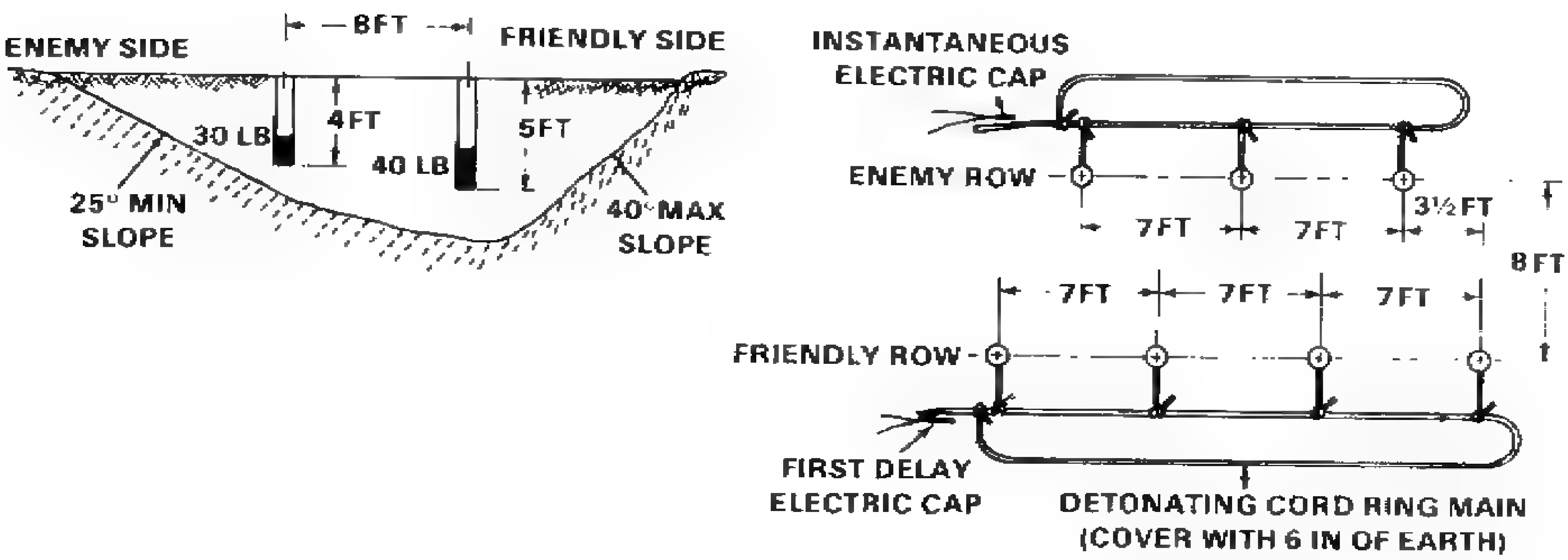


Figure 3-16. Charge placement for deliberate road crater

Relieved Face Road Crater

Effects of relieved face road crater. This method, shown in Figure 3 17, produces road craters that are more effective obstacles to modern tanks than the standard V-shaped craters. This technique produces a trapezoidal shaped crater about 7 to 8 feet deep and 25 to 30 feet wide with unequal side slopes. In compact soil, such as clay, the relieved face cratering method will create an obstacle such as the one illustrated in Figure 3-17. The side nearest the enemy slopes is approximately 25 degrees from the road surface to the bottom. The opposite or friendly side slopes are approximately 30 to 40 degrees from the road



NOTE: Dual priming recommended

Figure 3-17. Relieved face cratering

surface to the bottom. However, the exact shape of the crater depends on the type of soil involved. To create a relieved face road crater, use the procedures as follows:

- On dirt or gravel-surfaced roads, drill two rows of boreholes 8 feet apart, spacing the boreholes on 7-foot centers. On hard-surfaced roads, drill the two rows 12 feet apart. Use the following formula to compute the number of charges for the friendly-side row:

  $$N = \frac{L - 10}{7} + 1, \text{ where,}$$

  L = length of crater (in feet) measured across the width of the area to be cut. Round up any fractional number of holes to the next higher number. (13)

  Stagger the boreholes in the row on the enemy side in relationship to the other row, as shown in Figure 3-17. This row will always contain one less borehole than the friendly row.

- Make the boreholes on the friendly side 5 feet deep, and load them with 40 pounds of explosive. Make those on the enemy side 4 feet deep, and load them with 30 pounds of explosive.
- Prime the charges in each row separately for simultaneous detonation. There should be a delay of detonation of ½ to 1½ seconds between rows. Detonate the row on the enemy side first. Fire the friendly row of charges while the earth from the enemy side in the first detonation is still in the air. Use standard delay caps for delay detonation. Remember to still dual prime both rows.

If the firings cannot be staggered, acceptable results can be obtained by firing both rows simultaneously. However, the resulting crater will not have the same depth and trapezoidal shape as a relieved face road crater.

Prevention of misfires. To prevent misfires from the shock and blast of the row of charges on the enemy side (detonated first), protect the detonating cord ring mains and branch lines of the row on the friendly side (detonated last) by a covering of approximately 6 inches of earth.

Craters in Permafrost and Ice

Methods to blast permafrost. Permafrost can be as hard as solid rock. Therefore, procedures for blasting or cratering must be adapted to the permafrost condition.

In permafrost, blasting requires approximately 1½ to 2 times the number of boreholes and larger charges than those used in standard cratering formulas for moderate climates. Blasted frozen soil breaks into clods 12 to 18 inches thick and 6 to 8 feet in diameter. Because the charge has insufficient force to blow these clods clear of the hole, they fall back into it when the blast subsides. Conduct testing to determine the number of boreholes needed before extensive blasting is attempted.

Boreholes are made by standard drilling equipment, steam point drilling equipment, or shaped charges. Standard drilling equipment has one serious defect –the air holes in the drill bits freeze, and there is no known method to prevent this. Steam point drilling is satisfactory in sand, silt, or clay, but not in gravel. Place charges immediately upon withdrawal of the steam point; otherwise, the area around the hole thaws and plugs it. Shaped charges are also satisfactory for producing boreholes, especially for cratering. Table 3-5 on page 3-25 shows the size of boreholes in permafrost and ice made by M3A1, M2A3, or M2A4 shaped charges.

If available, use a low-velocity explosive such as ammonium nitrate for blasting holes in arctic temperatures. The heaving quality of low velocity explosives will aid in clearing the hole of large boulders. If only high-velocity explosives are available, tamp charges with water and permit them to freeze. Unless high-velocity explosives are thoroughly tamped, they tend to blow out of the borehole.

Methods to blast ice. Access holes are required for water supply and determining the thickness of ice to compute safe bearing pressures for aircraft and vehicles. Because ice carries much winter traffic, its bearing capacity must be ascertained rapidly when forward movements are required. Make small-diameter access holes by shaped charges. On solid lake ice, the M2A4 penetrates 7 feet, and the M3A1 penetrates 12 feet.

These charges can penetrate farther, but the penetration distances were tested only in ice approximately 12 feet thick. If the regular standoff distance is used, a large crater forms at the top and requires considerable probing to find the borehole. If a standoff of 42 inches or more is used with the M2A4 shaped charge, a clean hole without a top crater is formed. Holes made by the M2A4 average 3½ inches in diameter. Those made by the M3A1 average 6 inches in diameter.

In late winter after the ice has aged, it grows weaker and changes color from blue to white. Although the structure of ice varies and its strength depends on age, air temperature, and conditions of the original formation, the same type of crater is formed regardless of the standoff distance. If the lake or river is not frozen to the bottom and there is a foot or more of water under the ice, the water will rise to within 6 inches of the top after the hole is blown, carrying shattered ice particles with it. This makes the hole easy to clean. If the lake is frozen to the bottom, the blown hole will fill with shattered ice, and clearing will be extremely difficult. Under some conditions, shaped charges penetrate to a depth much less than that indicated in Table 3-5 on page 3-25.

Surface craters can be made with ammonium nitrate cratering charges or demolition blocks. For the best effects, place the charges on the surface of cleared ice and tamp on top with snow. Consider the tendency of ice to shatter more readily than soil when charges are computed.

Underwater charges. Place underwater charges by first making boreholes in the ice with shaped charges, and then placing the charge below the ice. An 80-pound charge of M112 demolition blocks under ice 4½ feet thick forms a crater 40 feet in diameter. This crater, however, is filled with floating ice particles and at temperatures around 20 degrees Fahrenheit freezes over in 40 minutes.

Vehicle obstacles. Crater a vehicle obstacle in ice by sinking boreholes 9 feet apart in staggered rows. Suspend the charges of tetrytol or plastic about 2 feet below the bottom of the ice by means of cord tied to sticks bridging the top of the holes. The size of the charge depends on the thickness of the ice. An obstacle like this can retard or halt enemy vehicles for approximately 24 hours at temperatures around -24 degrees Fahrenheit.

Craters at Culverts

A charge detonated to destroy a culvert not more than 15 feet deep may produce an effective road crater at the same time. Prime explosive charges for simultaneous firing, and thoroughly tamp with sandbags. Destroy culverts with 5 feet or less of fill by placing explosive charges the same way as in hasty road cratering. Place concentrated charges, equal to 10 pounds per foot of depth, in boreholes at 5-foot intervals in the fill above and alongside the culvert.

Craters for Antitank Ditches

Construction. In open country, antitank ditches strengthen prepared defensive positions. Because antitank ditches are costly in time and effort, much can be gained if the excavation is made by means of cratering charges. To be effective, an antitank ditch must be wide enough to stop an enemy tank. It can be improved by placing a log hurdle on the enemy side and the spoil on the friendly side. Improve the ditches by digging the face on the friendly side nearly vertical by means of hand tools.

Deliberate cratering method. The deliberate cratering method outlined in Chapter 3, Deliberate Road Crater, is adequate for the construction of heavy tank ditches in most types of soil.

Hasty cratering method. Construct an antitank ditch by placing 50 pounds of cratering explosive in 5-foot holes and spacing the holes at 5-foot intervals (Figure 3-15 on page 3-26). The ditch crater will be approximately 7 to 8 feet deep and 25 to 30 feet wide.

Ditches

In combat areas, construct ditches to drain terrain flooded by the enemy or as initial excavations for preparing a defense. Rough open ditches 2½ to 12 feet deep and 4 to 40 feet wide can be blasted in most soils. A brief outline of this method follows.

Test shots. Make test shots before attempting the actual ditching to determine the proper depth, spacing, and weight of charges needed to obtain the required results. Make beginning test shots with holes 2 feet deep and 18 inches apart, and then increase the size of the charge and depth, as required. A rule of thumb for ditching in average soil is to use 1 pound of explosive per cubic yard of earth to be removed.

Alignment and grade. Mark the ditch centerline by transit line or expedient means and drill holes. When a transit or hand level is used, control the grade of the ditch by checking the hole depth every 5 to 10 holes and at each change in

grade. In soft ground, make the holes with a sharp or quicksand punch, shown in Figure 3-18, or an earth auger. Load the holes, and tamp immediately to prevent cave-ins and ensure that the charges are at proper depth. Slope the ditches at a rate of 2 to 4 feet per 100 feet.

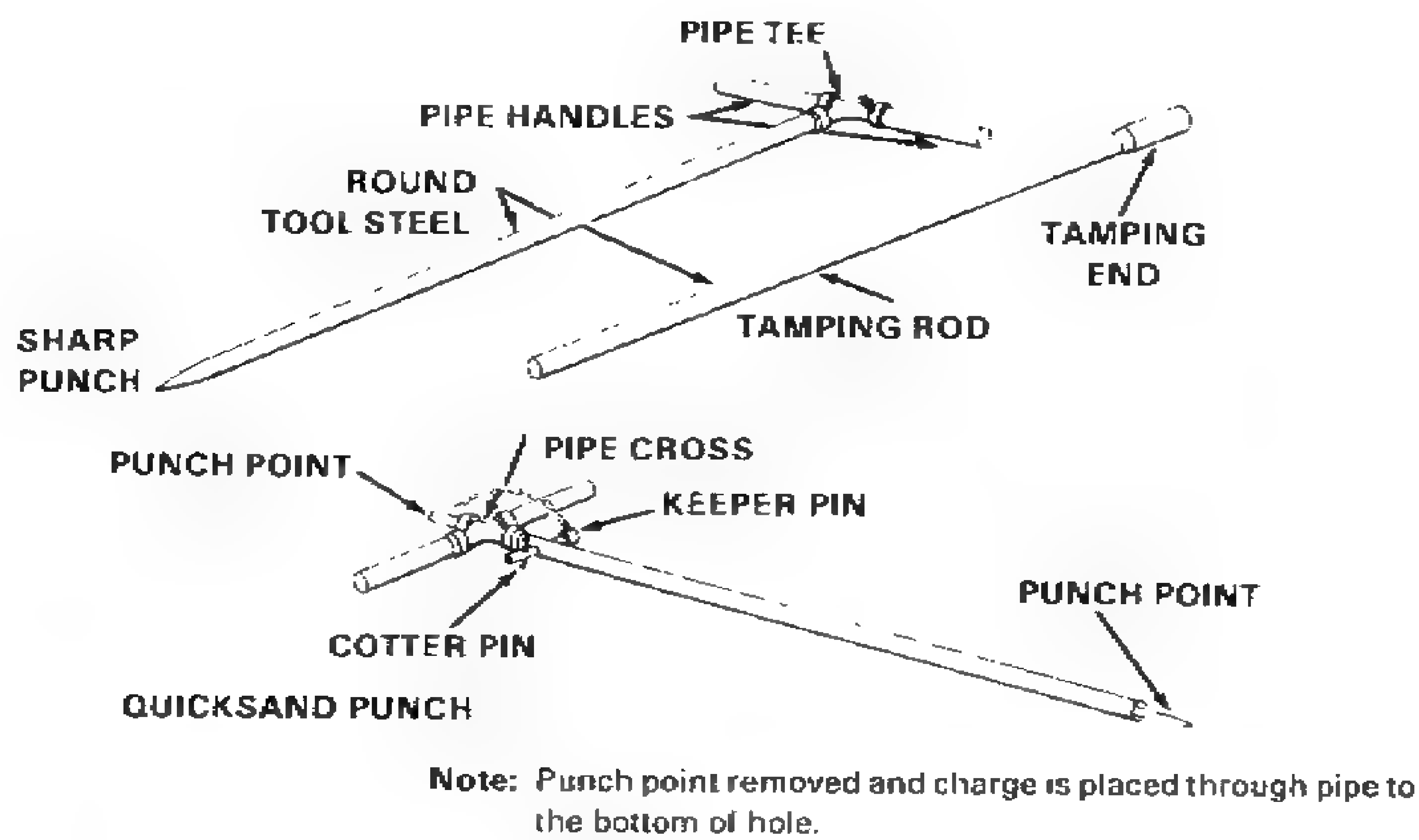


Figure 3-18. Punches used to place charges at proper depths in soft ground

Method of detonation. There are three methods of detonation—propagation, electrical firing, and detonating cord.

Only one charge is primed for the propagation method (Figure 3-19). Place the charge in the hole at one end of the line of holes made to blast the ditch. The

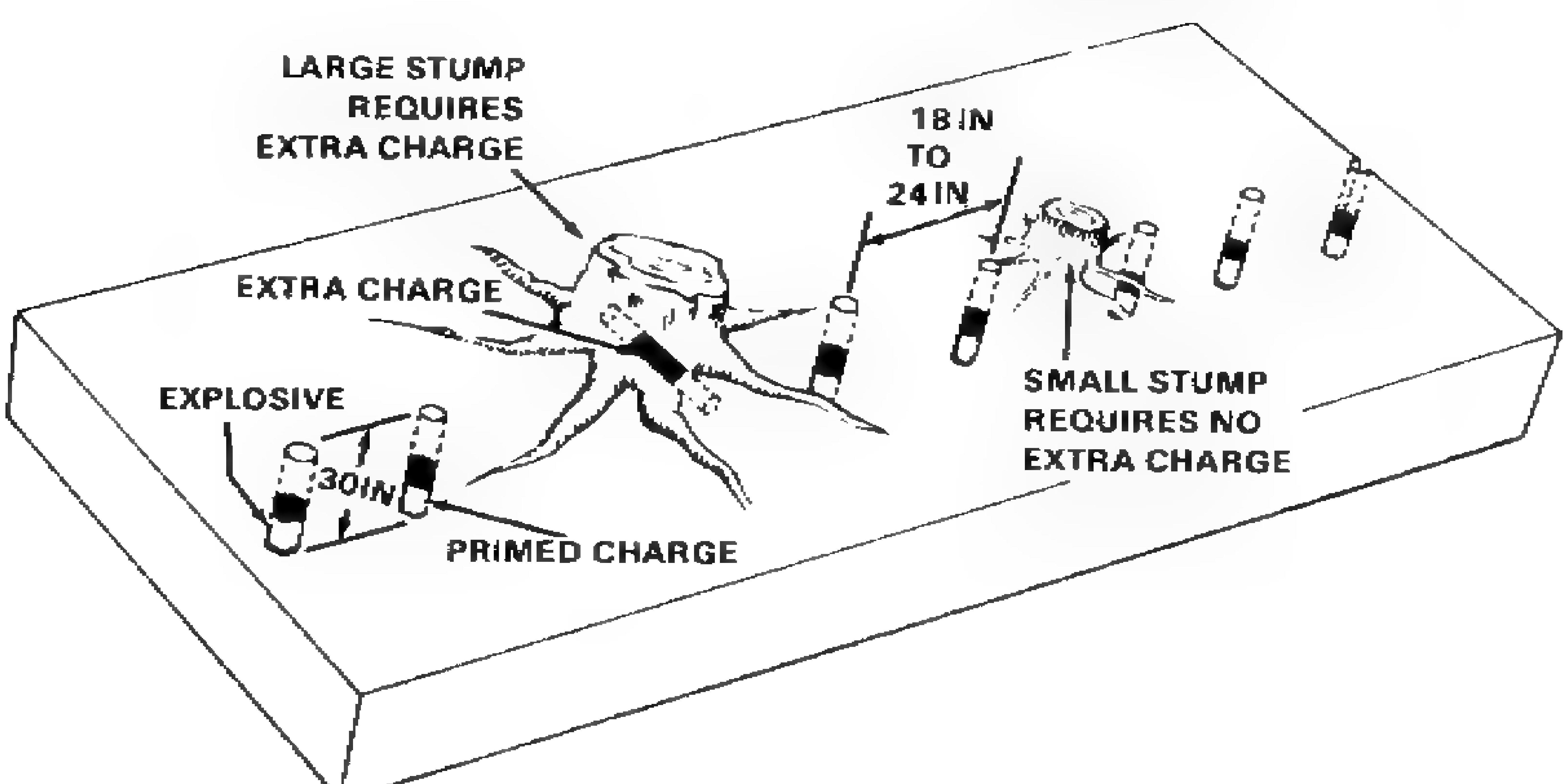


Figure 3-19. Propagation method of detonation

concussion from this charge sympathetically detonates the next charge and so on until all are detonated. Use no more than 50 to 60 percent straight commercial dynamite in this operation. The propagation method is effective only in moist or wet soils. It can be used effectively in swamps where the ground is covered by several inches of water. If more than one line of charges is required to obtain a wide ditch, prime the first charge of each line. Overcharge the primed hole 1 or 2 pounds.

Use any high explosive in ditching by the electrical firing method which is effective in all soils, regardless of moisture content, except sand. Prime each charge with an electric cap and connect the caps in a leapfrog series. Fire all charges simultaneously.

For the detonating cord method, use any high explosive. It is effective in any type of soil, regardless of moisture content, except sand. Prime each charge with detonating cord and connect to the detonating cord line main or ring main.

- **Method of loading.** Depending upon needs, load in one of several ways. The method of loading for a deep, narrow ditch is illustrated in Figure 3-20. The relief

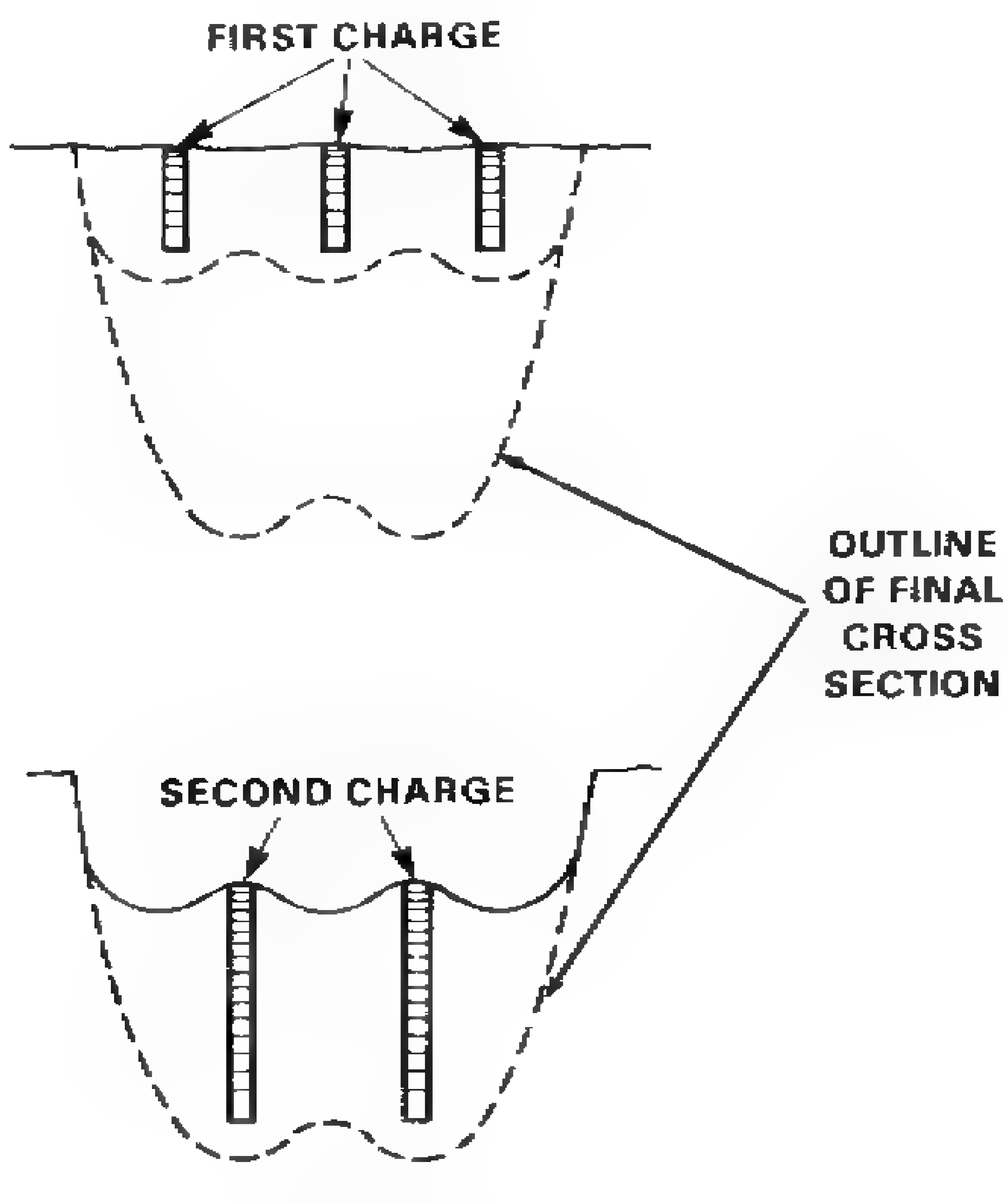


Figure 3-20. Method of loading a deep, narrow ditch

method of loading for shallow ditches is shown in Figure 3-21. Blast ditches 1 and 3 first to relieve ditch 2. Figure 3-22 illustrates the posthole method of loading for shallow ditches in mud. The cross-section method of loading to clean and widen ditches is explained in Figure 3-23.

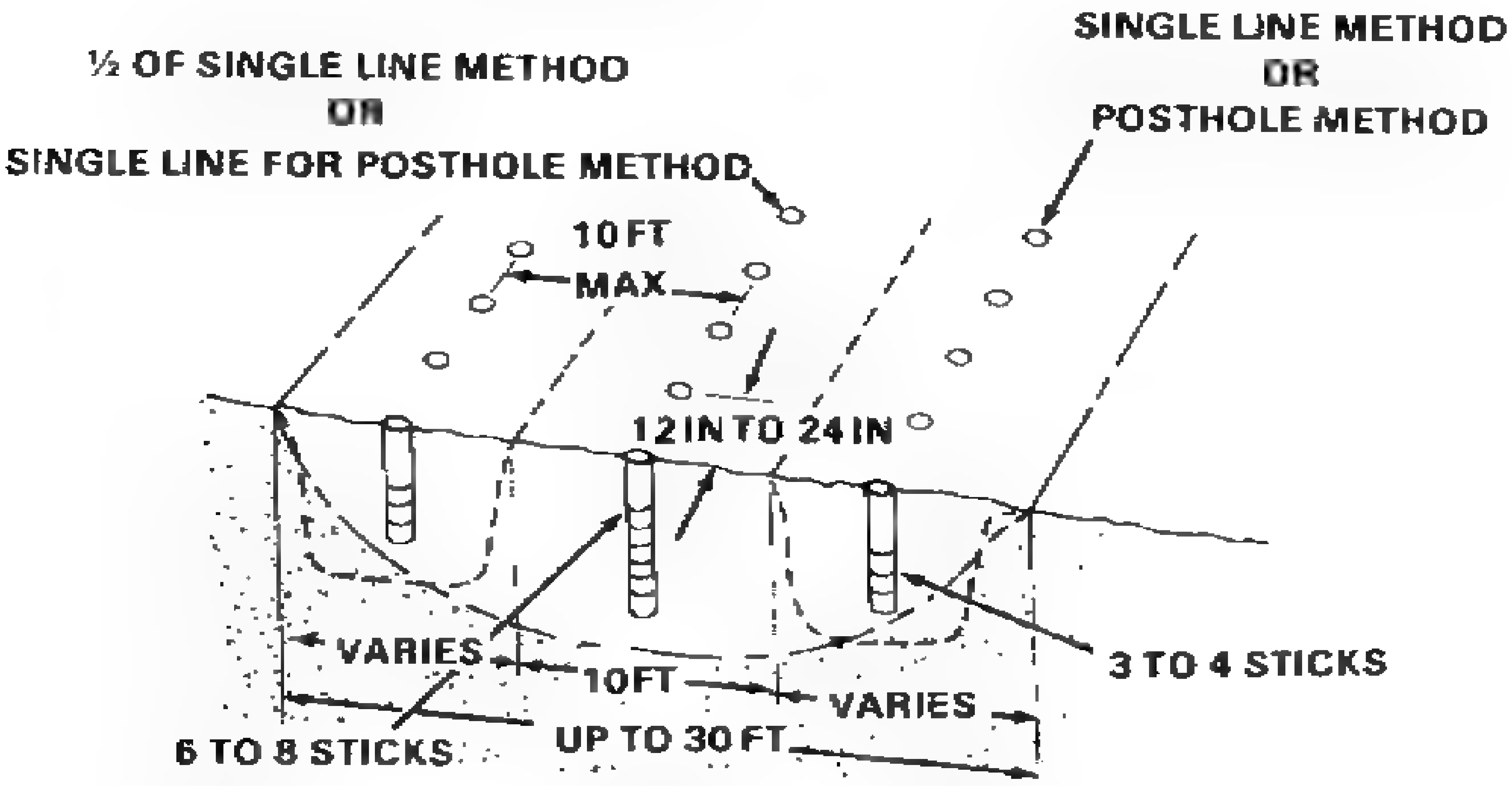


Figure 3-21. Relief method of loading for shallow ditches

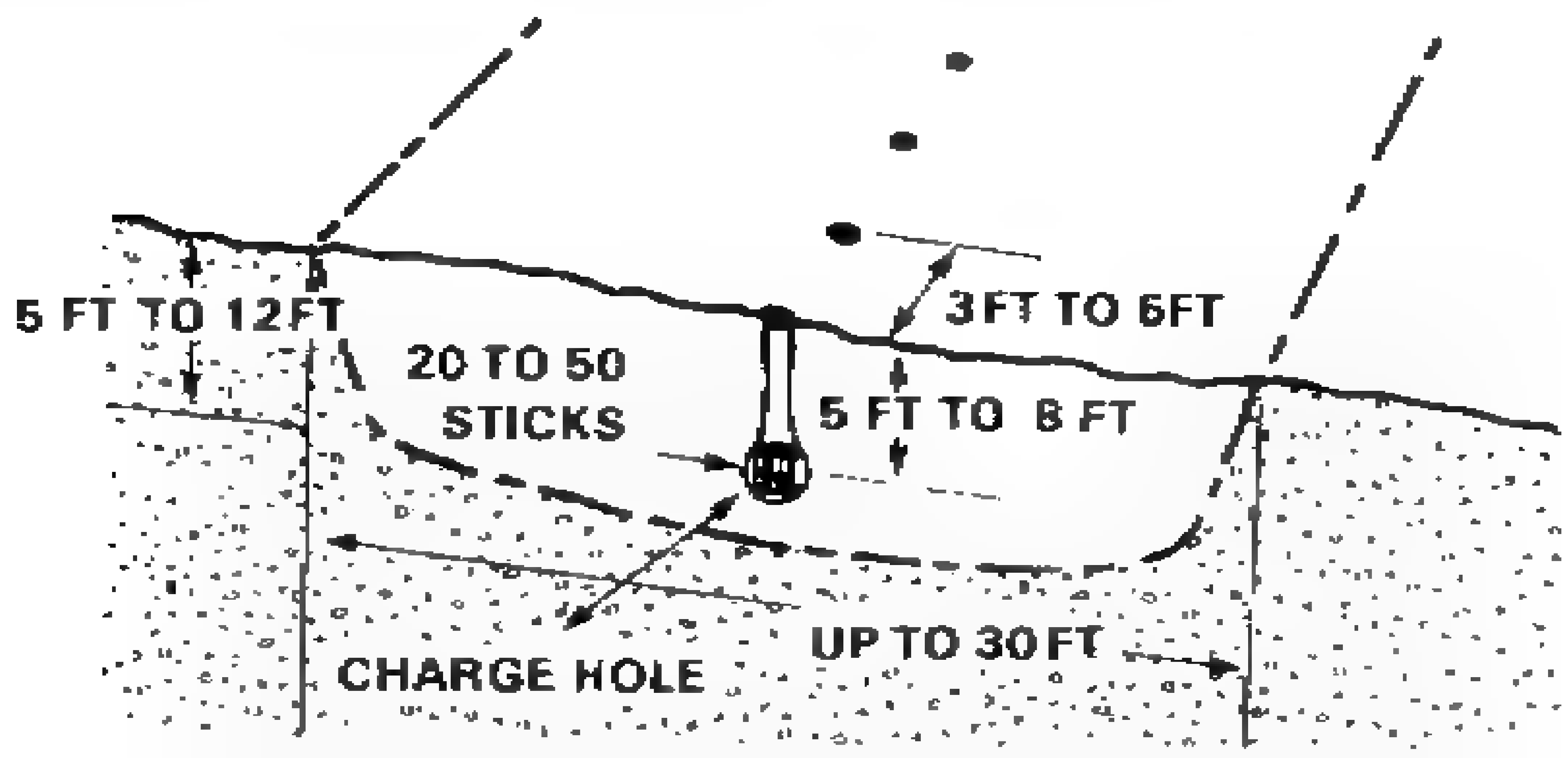


Figure 3-22. Posthole method of loading for shallow ditches in mud

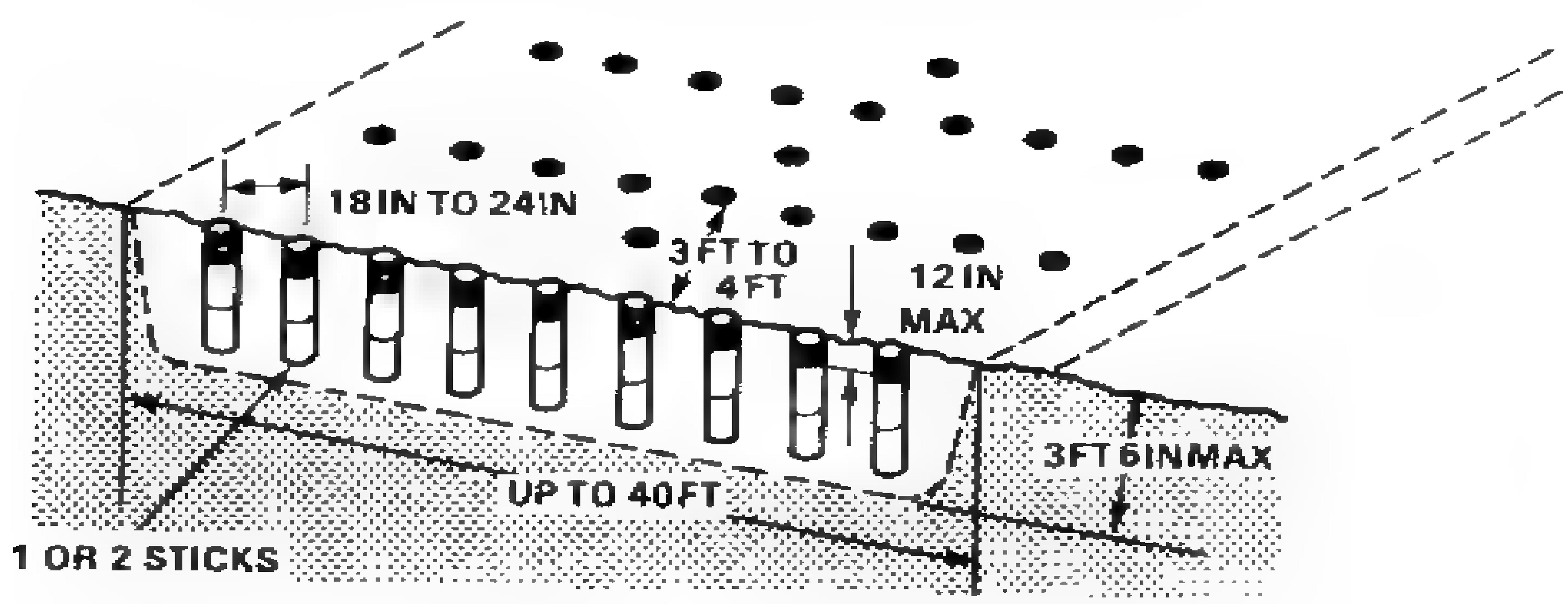


Figure 3-23. Cross-section method of loading to clean and widen ditches

LAND-CLEARING CHARGES

Overview

Explosives can be used in land-clearing operations, which includes stump and boulder removal, and quarrying. The explosives commonly used are military and commercial dynamite and detonating cord. The quantity of explosive used is usually calculated by a rule of thumb. Charges can be placed in boreholes in the ground under or beside the target. Tamp or mudcap all charges.

Stump Removal

Stumps are of two general types—taprooted and lateral rooted (Figure 3-24). Military dynamite is the explosive best suited for stump removal. Measure the diameter of a stump at a point 12 to 18 inches above the ground. Use 1 pound per foot of diameter for dead stumps and 2 pounds per foot for live stumps. If both trees and stumps are to be removed, increase the amount of explosive by 50 percent.

Taprooted stumps. For taprooted stumps, one method is to bore a hole in the taproot below the ground level. The best method is to place charges on both sides of the taproot to obtain a shearing effect (Figure 3-24). Tamp the charges for best results.

Lateral-rooted stumps. In blasting lateral-rooted stumps, drill sloping holes as shown in Figure 3-24. Place the charge as close as possible under the center of the stump and at a depth equal to the radius of the stump base. If the root formation cannot be determined, assume that it is the lateral type and proceed accordingly.

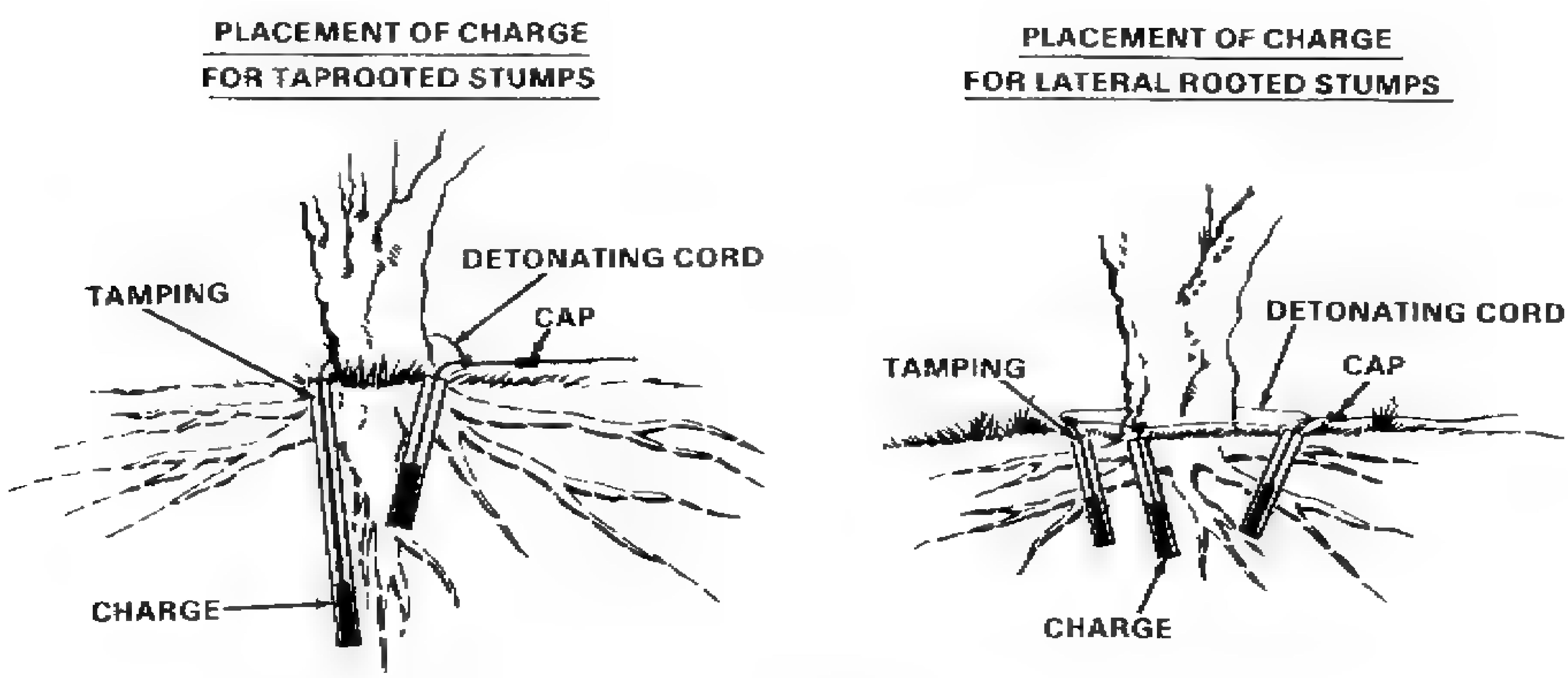


Figure 3-24. Stump blasting charges

Boulder Removal

Boulders can be removed by blasting. The most practical methods are snakeholing, mudcapping, and blockholing.

Snakeholing method. Dig a hole large enough to hold the charge under the boulder. Pack the explosive charge under and against the boulder as shown in Figure 3-25. For charge size, see Table 3-6.

Mudcapping method. Place the charge on top or against the side of the boulder wherever a crack or seam exists that will aid in breakage. Cover the charge with 10 to 12 inches of mud or clay (Figure 3-25). For charge size, see Table 3 6.

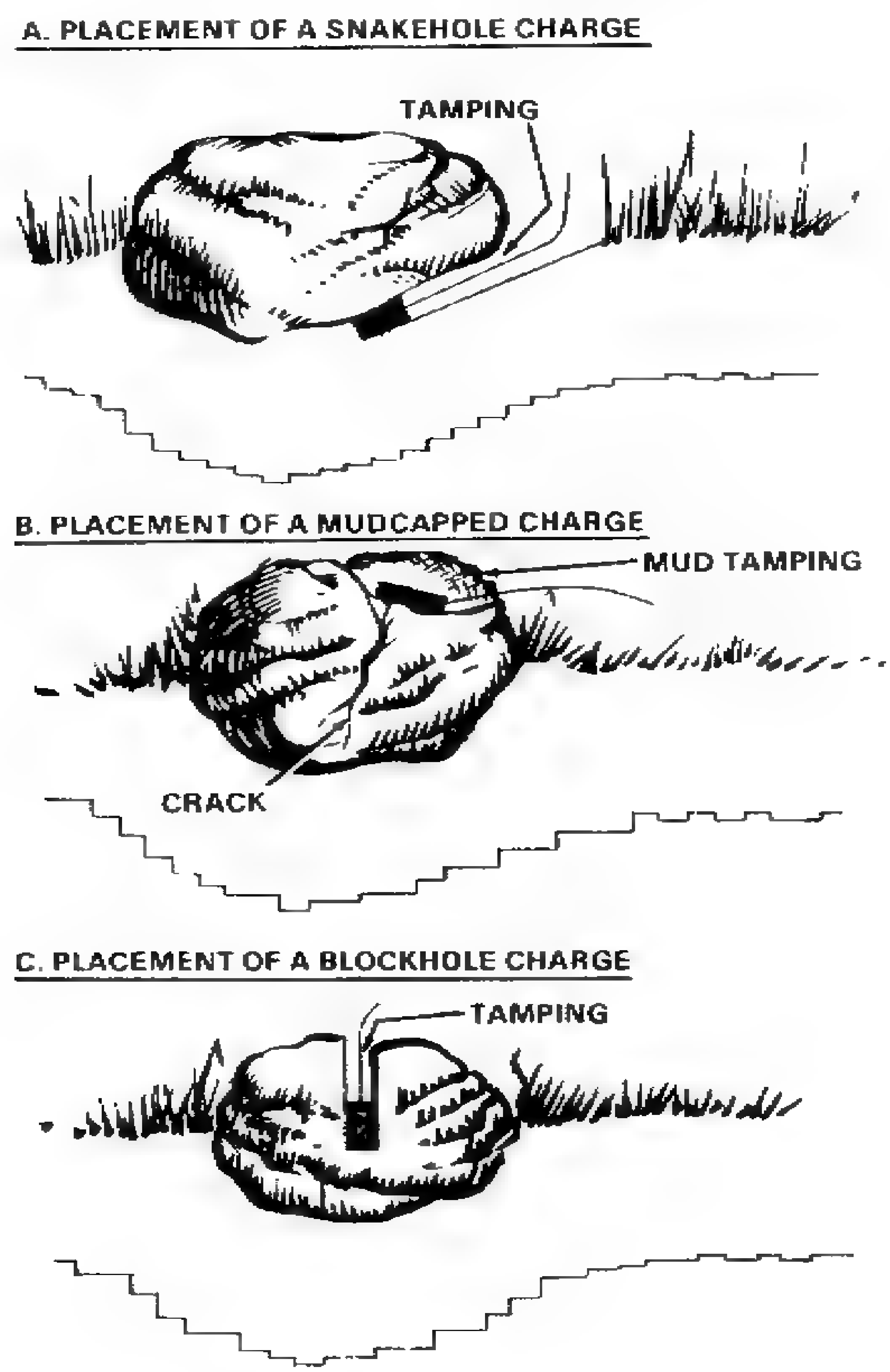


Figure 3-25. Boulder blasting charges

Blockholing method. Drill a hole on top of the boulder deep and wide enough to hold the amount of explosive indicated in Table 3-6. Prime the charge, place into the borehole, and stem (Figure 3-25).

Table 3-6. Charge size for blasting boulders

Boulder diameter, ft	Pounds of explosive required		
	Blockholing	Snakeholing	Mudcapping
3	¼	¾	2
4	⅜	2	3½
5	½	3	6

Springing Charges

Definition and method. A springing charge is a comparatively small charge detonated in the bottom of a drilled borehole to form an enlarged chamber for placing a larger charge. At times, two or more springing charges in succession may be needed to make the chamber large enough for the final charge. At least 2 hours should be allowed for the boreholes to cool between firing and placing successive charges unless the sprung holes are cooled with water or compressed air.

Detonating cord wick. Tape together several strands of detonating cord 5 to 6 feet long, insert into the hole, and detonate to enlarge boreholes in soils. One strand generally widens the diameter of the hole about 1 inch.

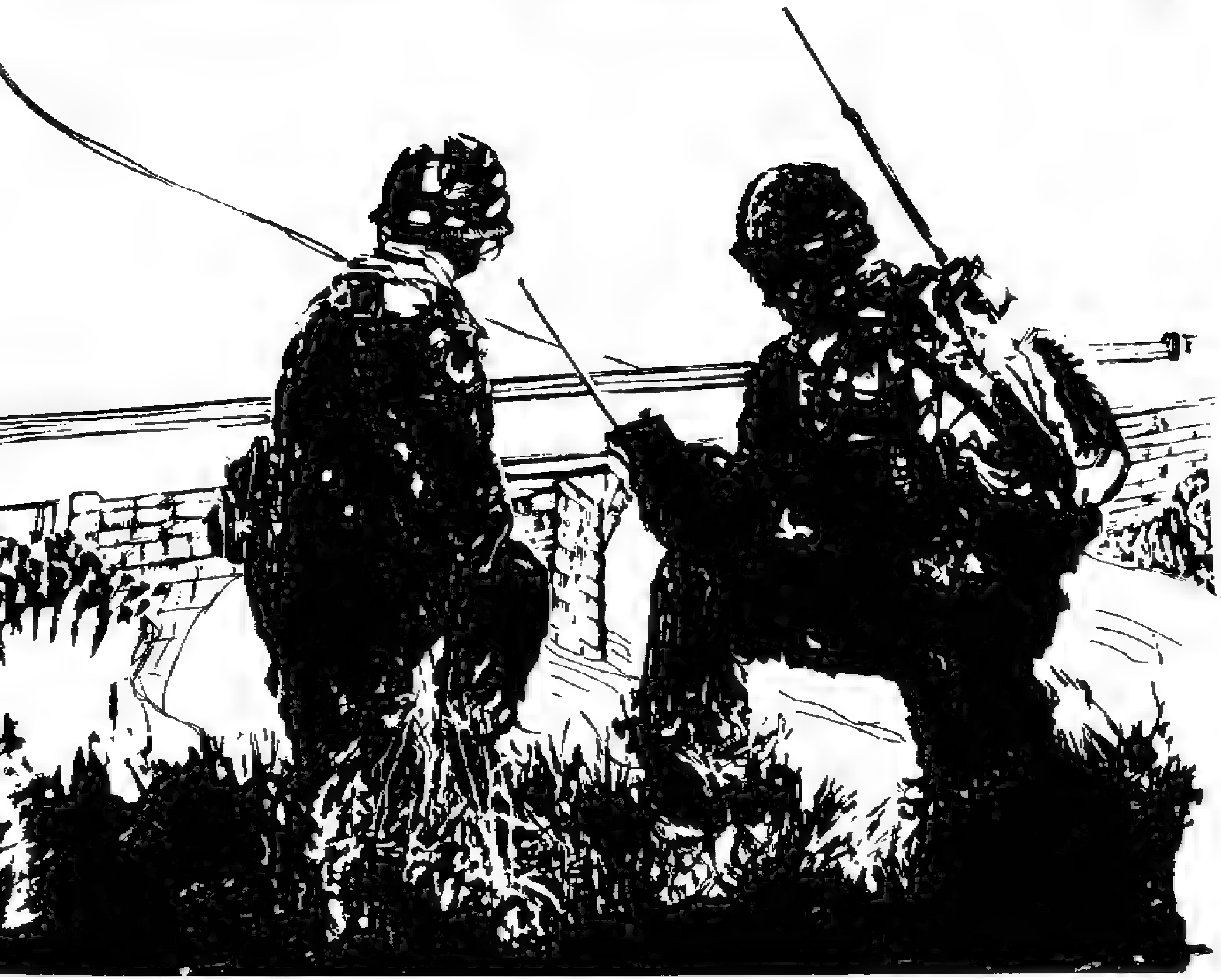
Make a hole by driving a steel rod approximately 2 inches in diameter into the ground to the depth required. According to the rule of thumb, a hole 10 inches in diameter requires 10 strands of detonating cord. The strands must extend the full length of the hole and be taped or tied together into a wick to give optimum results. Place the wick into the hole by an inserting rod or some other field expedient. Firing can be done electrically or nonelectrically. An unlimited number of wicks can be fired at one time by connecting them with the detonating cord ring main or line main.

The best results from the use of the detonating cord wick are obtained in hard soil. If successive charges are placed in the holes, blow out excess gases and inspect the hole for excessive heat.

Quarrying

Quarrying is the extraction of rock in the natural state. Military quarries, generally of the open-face type, are developed by the single or multiple bench method. See TM 5-332 for detailed information.

demolition projects 4



This manual explains the methods and techniques in selecting, calculating, priming, placing, and firing explosives on materials such as steel, concrete, wood, stone, and earth. This chapter deals with the problems of using these techniques in demolition projects.

DEMOLITION PLAN

Demolition Obstacles

Although demolitions can be used in a wide range of projects, such as quarrying, land clearing, and ambushing, the most important military use of demolition is that of creating demolition obstacles. Demolition obstacles are used in conjunction with many other types of obstacles, including mines, to create barriers which control the movement of an opposing force. Demolitions are also used in denial operations to create obstacles and to destroy facilities or material.

Barriers and Denial Operations

The use of extensive barriers and the execution of denial operations are normally directed by division or higher commanders. These tactics are based on careful planning and are closely coordinated with all tactical plans. Engineer units are responsible for furnishing technical advice and supervision, siting and constructing specific obstacles or barriers, estimating the requirements for obstacle materials, and recommending the allocation of engineer resources. The construction of demolition obstacles is normally assigned to engineer units because the use of demolitions requires special skills and equipment. For further information, see FM 31-10.

Demolition Planning

Execution of a demolition project. The execution of a demolition project must be based upon careful planning and reconnaissance.

Selection of a demolition project. Factors that determine the selection and extent of demolition projects are—

- The mission of the command.
- The limitations and instructions of higher authority.
- The current tactical and strategical situation and future plans that indicate the length of time the enemy must be delayed, the time available for demolition, and the extent of denial to be accomplished.
- The enemy's capabilities and limitations as well as the effect of the denial upon them strategically and tactically.
- The likelihood that friendly forces may reoccupy the area and be required to neutralize the obstacle.
- The results to be obtained by the expenditure of labor and materials compared to the results that may be obtained elsewhere with the same amount of effort.
- The time, material, labor, and equipment available.
- The effect on the local population.
- The target protection required.

Demolition Reconnaissance

Demolition reconnaissance report. Thorough reconnaissance is necessary before a plan can be made to demolish a target. Reconnaissance provides information in all areas related to the project. Use Department of the Army (DA) Form 2203-R (Demolition Reconnaissance Report), shown in Figure 4-1, together with appropriate sketches to record and report the reconnaissance of a military demolition project. Copy of DA Form 2203-R (Demolition Reconnaissance Report) is contained at Appendix E.

DEMOLITION RECONNAISSANCE REPORT

For use of this Form see FM 5-25. The proponent agency is TRADOC.

SECTION I - GENERAL

1. FILE No.	2. DML RECON RPT No.	3. DATE	4. TIME
103-86-15	86-15	7 JAN 86	1630

	NAME	GRADE	ORGANIZATION
5. RECON ORDERED BY	SHAVER, D. H.	LTC	12th ENG. BN.
6. PARTY LEADER	BURAK, M. H.	SSG	12th ENG. BN.

7. MAP NAME Ft. Belvoir Special SCALE 1/12,500 SHEET # SERIES #

8. TARGET AND LOCATION	9. TIME OBSERVED	10. COORDINATES
Railroad Bridge Rt. 68 and 33	1930 Hrs.	AH23069609

11. GENERAL DESCRIPTION (attach sketches)

Railroad Bridge, Steel Girder

12. NATURE OF PROPOSED DEMOLITION (attach sketches)

Partial Destruction

13. UNUSUAL FEATURES OF SITE

NONE

SAMPLE

SECTION II - ESTIMATES*

14. EXPLOSIVES REQUIRED

a. Types	b. Quantity	c. Caps		d./e.		f./g.	
TNT (1 lb.)	84	Electric	0	d. Detonating Cord	200 FT.	f. Fuse Lighters	5
		Nonelectric	10	e. Time Fuse	50 FT.	g. Firing Wire	0

15. EQUIPMENT AND TRANSPORT REQUIRED

Demo Kit, Carpenter Kit, 1 by Material For Bracing
2½-Ton or 5-Ton Trucks

16. PERSONNEL AND TIME REQUIRED FOR:	NCO's	Men	Time
a. PREPARING AND PLACING THE CHARGES	1	9	3 Hrs.
b. ARMING AND FIRING THE DEMOLITION	1	2	10 Min.

17. TIME, LABOR AND EQUIPMENT REQUIRED FOR BYPASS; SPECIFY LOCATION AND METHOD

Bailey Bridge, Double-Double 6 Hrs.
1 Platoon

* Determine availability of Items 14, 15 and 16 before reconnaissance.

DA FORM 2203-R, AUG 70

When time and conditions permit, this report provides information for the preparation of an obstacle folder. (See Chapter 4, Obstacle Folder.) If the obstacle folder is not available, use this report in its place. The information provided in the form and listed in the next paragraph is intended primarily for bridge and road demolitions, but it is also applicable to the demolition of almost any other object. In certain instances, the report may require a security classification. The DA Form 2203-R will be locally reproduced on 8- by 10½-inch paper (image size 7 by 9 1/16 inches). (See Appendix E.)

Information required. DA Form 2203-R should contain the information as follows:

- A situation map sketch showing the relative position of the objects to be demolished, the surrounding terrain features, and the coordinates of the objects keyed to existing maps.
- A list of all unusual features of the site, giving the location on the situation map sketch.
- A plan and a side-view sketch of the demolition object showing overall dimensions, lines of cut, and demolition chambers. For example, if a bridge is to be destroyed, a sketch showing the overall dimensions of its critical members is necessary.
- A plan and cross-section sketch, for each member to be cut, showing details of chambers, lines of cut, and location of charges, with accurate dimensions of each member, quantities of explosives, and method of ignition.
- A sketch showing firing circuits and firing point.
- A bill of explosives showing the quantity and types required.
- A list of all equipment, including transportation, required for the demolition.
- An estimate of time and labor required for preparing the demolitions and placing the charges.
- An estimate of time and labor required for arming the charges and firing the demolition.
- An estimate of time, labor, and equipment required to bypass the obstacle. Specify the location and method. Include supplementary obstacles, such as mining, that may be required.

Demolition Orders (Standardization Agreement (STANAG) 2017, Edition 3, Quadripartite Standardization Agreement (QSTAG) 508)

The following is a paraphrase of STANAG 2017, beginning with paragraph 3. It explains the standard procedure for conducting a demolition project.

Three commanders are normally concerned with the execution of a demolition. One is the military authority who has overall responsibility. This person is the officer empowered to order the firing of the demolition (referred to hereafter as the Authorized Commander)

The second is the Demolition Guard Commander (when appointed).

The third is the Demolition Firing Party Commander who is in technical charge of the preparation, charging, and firing of the demolition.

Each Authorized Commander will--

- Determine the requirement and allot responsibility for a Demolition Guard.
- Establish a clearly understood communication channel whereby the order to fire the demolition is transmitted to the Demolition Guard Commander or, if there is no Demolition Guard, to the Demolition Firing Party Commander.
- Ensure that this channel is known and understood by all concerned.
- Specify whether the Demolition Guard Commander is authorized to order the firing of the demolition if the enemy is in the act of capturing it.

Where a demolition important to the operational plan is to be prepared, the Authorized Commander will normally appoint a Demolition Guard, the Commander of which will be responsible for—

- Ensuring, if so ordered, that the demolition is not captured intact by the enemy.
- Giving to the Demolition Firing Party Commander the orders for changing the state of readiness of the demolition and the firing orders.

Instructions to the Demolition Guard Commander and Demolition Firing Party Commander are contained in Annex A of the STANAG (Figure 4-2, page 4-6). This form will be used whenever time and conditions permit.

After Part I of the form in Annex A has been completed, copies will be distributed in accordance with the distribution list on the form.

When the demolition is complete, copies number 1 and 2 of Annex A will be disposed of in accordance with the instructions on the form.

The contents and paragraph numbers of the form issued by each national authority must conform exactly to Annex A. The form issued by each national authority should also conform as closely as possible, both in size and shape, to the example of Annex B (Figure 4-2, page 4-6).

Obstacle Folder

Purpose. Use the obstacle folder to provide all the information needed to destroy a target. It is used for all nonnuclear demolition targets planned in barrier and denial operations (See FM 31-10). Prepare the obstacle folder in the format described in the following text and illustrated in Figure 4-3, page 4-11, whenever time and procedures that follow are in accordance with the STANAG 2123.

Contents. The obstacle folder consists of five parts. They are—

- Location of targets
- Supply of explosives and equipment.
- Orders for preparing and firing.
- Handover/takeover procedures.
- Demolition report.

(Security Classification)

ORDERS FOR THE DEMOLITION
(USAEREUR Reg 525 2 STANAG 2017)

INSTRUCTIONS FOR PREPARING THIS FORM

i Paragraphs 1-9 are to be completed placing a cross in each box where applicable

ii Copy No 1 is to be issued to the Demolition Guard Commander and Copy No 2 to the Firing Party Commander Copy No 3 is retained by the Authorized Commander If there is no Demolition Guard, Copy No 1 is issued to the unit providing the firing party

iii If the Demolition Guard Changes, a new form should be issued

ORDERS TO THE DEMOLITION GUARD COMMANDER

iv You are responsible for

a Command of the Demolition Guard and Demolition Firing Party

b The security of the demolition site from enemy attack or sabotage, and the control of traffic and refugees at the demolition site

c. Giving the order to the Demolition Firing Party Commander in writing (para 10 of Copy No 2) to change the State of Readiness

d Giving the order to the Demolition Firing Party Commander in writing (para 13 of Copy No 2) to fire the demolition

e Keeping the Authorizing Commander informed of the operational situation at the demolition site

v The Demolition Firing Party Commander is in technical control of the demolition but you must ensure that he keeps you informed of all action he takes Your command post should be co-located with the firing point if possible

vi. You are to find out from the Demolition Firing Party Commander the time required to change the demolition from State of Readiness 1 (SAFE) to State of Readiness 2 (ARMED), pass this information to the Authorized Commander and record it in para 10a

vii. You are to nominate a deputy forthwith and compile a seniority roster. You are to ensure that each man knows his place in the roster understands his duties, and knows where to find this form if you become a casualty or are unavoidably absent The seniority roster must be made known to the Demolition Firing Party Commander

viii Once State of Readiness 2 (ARMED) has been ordered, either you or your deputy must always be at your command post so that orders can be passed immediately to the Demolition Firing Party Commander.

ix In the event of a misfire or only partially successful demolition you are to give the Demolition Firing Party protection until such time as it has completed the demolition

x If you are ordered to hand over the demolition to another unit without the issue of a new form para 13 is to be completed and the new form handed to the new Demolition Guard Commander A receipt is to be issued and retained by you If a new form has been issued, para 13 is to be completed on the old form which you will retain.

xi. When the demolition has been completed, you are to report its effectiveness to the Authorized Commander by the fastest means available and return Copy No 1 to him with para 14 completed

xii. If you receive orders to fire the demolitions other than those given in para 5, you should refer to the Authorized Commander

ORDERS TO THE DEMOLITION FIRING PARTY COMMANDER

xiii You are in technical charge of the preparation, charging, and firing of the demolition.

xiv The Demolition Guard Commander (if one is provided) is responsible for

a. Tactical command of all troops at the demolition site; you are therefore under his command

b. Giving you in writing (para 10) the order to change the State of Readiness.

c. Giving you in writing (para 13) the order to fire the demolition

xv. You are to consult with the Demolition Guard Commander over the siting of your firing point which is to be co-located with his command post whenever practicable It should be within sight of the target

xvi. You are to nominate a deputy forthwith, and compile a seniority roster. You are to ensure that each man knows his place in the roster, understands his duties, and knows where to find this form if you become a casualty or are unavoidably absent The seniority roster is to be made known to the Demolition Guard Commander

xvii You are to complete para 10e of the form and to report this information to the Demolition Guard Commander if provided, otherwise to the Authorized Commander.

xviii. Once State of Readiness 2 (ARMED) has been ordered, either you or your deputy must remain at the Firing Point

xix When there is no Demolition Guard and you receive orders to fire the demolition other than those given in para 5, you should refer to the Authorized Commander or to your immediate superior.

xx. If you are ordered to hand over the demolition to another unit without the issue of a new form para 11 is to be completed and the form handed to the new Demolition Firing Party Commander A receipt is to be issued and retained by you If a new form has been issued, para 11 is to be completed on the old form, which you will retain

xxi When the demolition has been completed, you are to report its effectiveness to your Unit Commander by the fastest means available, and return Copy No 2 to him with para 14 completed If there is no Demolition Guard the Unit Commander must pass the results and the completed Copy No 1 to the Authorized Commander If mines are laid, they are to be reported and recorded on a minefield record (STANAG 2036)

(Security Classification)

Figure 4-2. Orders to the demolition guard commander and demolition firing party commander

(Security Classification)

COPY NO ____ OF ____

DEMOLITION ORDER
SERIAL NO __________

From . . .

(Authorized Commander)

1. Demolition Guard Commander
2. Demolition Firing Party Commander
3. Retained by the Authorized Commander
4. . .

PART I

1 Demolition Target Details

a Description . . . .

b Location (grid coordinates) . . . .

c Target nickname, number, or codeword
(All orders are to be prefixed by target identifying nickname, number, or codeword.)

d Technical instructions . . . .

. . . .

2 Executing Units

a. Demolition Guard . . . .

b Demolition Firing Party . . . .

3 Orders to the Demolition Firing Party Commander

a. The demolition target is to be prepared to State of Readiness . . . . by . . . . (DTG).

b ☐ All other orders will be issued to you by the Demolition Guard Commander. Record their receipt in Part II.

c ☐ There is no Demolition Guard. You are to act as instructed in para 5, 6, and 7, recording the orders received in Part II.
(Only one box is to be crossed)

4 Orders to the Demolition Guard Commander

Your responsibilities are detailed in Part IV. You are to act as instructed in para 5, 6 and 7, recording the orders received in Part II.

5 Demolition is to be fired

a. ☐ Immediately upon being prepared.

b ☐ Upon receipt of codeword in para 8c by radio

c. ☐ Upon receipt of the order from the Authorized Commander or his Liaison Officer personally

d ☐ (Other orders) . . . .

6 Emergency Firing Orders

a ☐ You will NOT fire the demolition except as ordered in para 5

b. ☐ You WILL fire the demolition on your own initiative if the enemy is in the act of capturing it
(Only one box is to be crossed)

7. Orders other than for firing will be given.

a ☐ By the Authorized Commander personally

b ☐ By the Authorized Commander's Liaison Officer personally.

c. ☐ By radio

d ☐ . . . . (other means)

(Security Classification)
2

Figure 4-2. Orders to the demolition guard commander and demolition firing party commander (continued)

(Security Classification)

8. Codewords

Action to be taken	Codeword
a. Change from State 1 (SAFE) to State 2 (ARMED)	
b. Change from State 2 (ARMED) to State 1 (SAFE)	
c. Fire the demolition now	
d. Para 3b cancelled, para 3c applies	
e. Para 3c cancelled, para 3b applies	
f. Para 5c cancelled, para 5b applies	
g. The Authorized Commander is changed to	
h.	
i.	

9. Authorized Commander

Signature . . . . Rank/Name . . . .

Appointment . . . . Date/Time Group . . . .

PART III

10. Changing State of Readiness

a. Time estimated by Firing Party Commander to change from State of Readiness 1 (SAFE) to State of Readiness 2 (ARMED) is . . . . minutes.

b.

State of Readiness Ordered	Originator	Date/Time Group of:	
		Receipt of Order	Change Completed

11. Handover and Takeover of Demolition Target

	Rank, Name and Unit	Signature	Date/Time Group
Transferring Commander			
Accepting Commander			

(Security Classification)
3

Figure 4-2. Orders to the demolition guard commander and demolition firing party commander (continued)

(Security Classification)

12 Record of Other Changes to Part I (if any)

Detail	Date/Time of Receipt

13 FIRE THE DEMOLITION NOW

Signed ....

(Rank, name, unit) ....

(Date/Time Group) ....

(or enter date/time group of receipt of codeword in para 8c)

PART III

14 Demolition Report

a Bridge
Estimated width of gap ....
No of spans down ....

b. Road/Runway/Railway
No of craters ....
Diameter/Depth ....

c Other target ....

d. Mines laid. AT mines .... AP mines ....

Sketch

Signature .... Rank/Name/Unit ....

(Security Classification)
4

Figure 4-2. Orders to the demolition guard commander and demolition firing party commander (continued)

The parts are to be in the order as indicated and in the pattern illustrated in Figure 4-3. If additional information is considered necessary, insert the information in the appropriate place in the folder. When there is insufficient space to enter the information, insert additional pages. In such cases, make a notation in the appropriate place (for example, "See page 4a"), and insert the additional page immediately following the notation.

Format. The obstacle folder is intended for use in the field by the commander of the demolition firing party. It must have a strong, durable cover and must be bound so that pages with maps, stores lists, report forms, and so forth, can be easily removed. Prepare the folder in a pocket size, approximately 6 by 8¼ inches

Language. The unit preparing the folder may speak a different language than the unit carrying out the demolition. Therefore, it is essential to produce the obstacle folder in more than one language.

Prepare the obstacle folder in the languages that follow:

- Language(s) of units concerned.
- Language of the host nation.
- One of the two official North Atlantic Treaty Organization (NATO) languages (English or French).

Complete all subject matter in the folder in all languages agreed on for the folder. Notes on maps, plans, sketches, and so forth are to be in one language only, with a translation of relevant items in the other language(s) at the bottom of the page.

Special instruction. The instructions that follow apply to the format shown in Figure 4-3.

The list of explosives and stores required that is given in this format, found in part (2d) of Figure 4-3, is not intended to be exhaustive. It does indicate, however, a logical order of recording the various items. Include in the list only those items required for a particular target.

Use the special technical instructions given in Figure 4-3, part (3a), when size, composition, and mission of the various parties employed on preparations for a major task are to be noted in paragraph 5, Organization of Work.

The section pertaining to mines, found in part (3e) of Figure 4-3, concerns only nuisance mines, if applicable, or protective mines laid to protect the target and does not mean barrier minefields.

Fill in the Demolition Report, found in Figure 4-3 in part (5) and paragraphs a and b. Detach this sheet for use as a demolition report form upon completion of the demolition. Squared paper is provided at the back for making a sketch.

Annex/annexe 'A' (DofA) (MdeA) to/au STANAG 2123
Anhang 'A' (DofA) zum STANAG Nr. 2123

NATO-CONFIDENTIAL on completion	+NATO-RESTRICTED
OTAN-CONFIDENTIEL une fois remplie	+DIFFUSION RESTREINTE
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN	+VS-NUR FÜR DEN DIENST- GEBRAUCH
nach Ausfüllen	ab Alarmmaßnahme

OBSTACLE FOLDER
CARNET D'OBSTACLE
SPERRHEFT

Type of obstacle	
Type d'obstacle	
Art der Sperre	

CLASS 1.++PRELIMINARY 2.++RESERVED	CATEGORIE 1.++Préliminaire 2.++DE MANOEUVRE (1) RESERVE (1)	DRINGLICHKEIT 1.++Sofort-Maßnahme 2.++Reserviert	

Serial number						
Numero d'ordre						
Laufende Nummer						

Target no.						
Dispositif No.						
Objektnummer						

Copy	Exemplaire	Ausfertigung	
	No.		

NOTE Anmerkung

\+ When blank
Si laissé en blanc
Wenn unausgefüllt

++ Strike out item not applicable
Rayer la mention inutile
Nicht zutreffendes streichen

(1) Delete the term NOT used
Barrer la mention NON utilisée

-1-

Figure 4-3. Obstacle folder

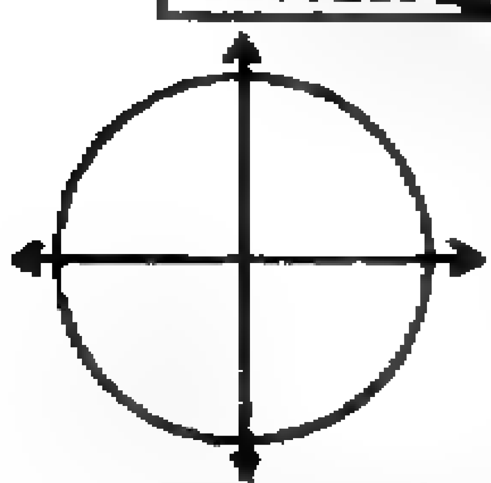
NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(*) PHOTOGRAPH OF TARGET PHOTOGRAPHIE DE L'OUVRAGE

FOTOGRAPHIE DES SPERRObJEKTS

SAMPLE

DESCRIPTION	DESCRIPTION	BESCHREIBUNG	



Indicate direction of view

Indiquer direction de prise de vue

Richtung, in der das Objekt gesehen wurde, einzuzeichnen

MAP NAME AND SCALE	NOM ET ÉCHELLE DE LA CARTE	KARTENBEZEICHNUNG UND MASS-STAB

GRID REFERENCE OF TARGET	COORDONNEES DU DISPOSITIF	KOORDINATEN DES OBJEKTS

Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(m) LOCATION OF TARGET AND PRESTOCK POINT.	EMPLACEMENTS DU DISPOSITIF ET DU CENTRE DE RATTACHEMENT (PRESTOCKAGE).	LAGE DES OBJEKTS UND MUNITIONSLAGERPLATZ.

(Map of scale 1:250.000 showing target and prestock point and route between them.

Indicate nearest telephone (pick up point (if any) into the AUTOKO network (Corps trunk communications system).

(Cart au 250.000e renseignant sur le dispositif, le lieu de stockage des munitions et l'itinéraire reliant ces deux points.

Indiquer (s'il existe le réseau RTT, le numéro de telephone le plus proche).)

(Karte im Maßstab 1:250.000 mit der Lage des Objekts und Munitionslagerplatz und Marschweg für Munitionstransport.

Nächsten Posthauptanschluß (wenn vorhanden) in das AUTOKO-Netz angeben.)

SCALE	ÉCHELLE	Maßstab	1:250.000

- 3 -

Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completions
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(1b) LOCATION OF TARGET	EMPLACEMENT DU DISPOSITIF	LAGE DES OBJEKTS

(Map of scale 1:50.000 showing the target and adjacent targets.)

(Carte au 50.000e renseignant sur le dispositif et les dispositifs voisins.)

(Karte im Maßstab 1:50.000 mit Lage des Objekts und der Nachbarobjekte.)

SCALE	ÉCHELLE	Maßstab	1:50.000

-5-

Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois rempli
VS-VERTRAULICH
AMTLICH GEHEIMGEHALTEN
nach Ausfullen

(2) SUPPLY OF EXPLOSIVES AND STORES FOR TARGET	APROVISIONNEMENT DU CHANTIER DU DISPOSITIF	VERSORGUNG MIT SPRENG- UND ZÜNDMITTELN SOWIE GERAT FÜR DAS OBJEKT
1-PRESTOCK POINT.	CENTRE DE RATTACHEMENT (PRESTOCKAGE)	MUNITIONS-LAGERPLATZ

NAME	NOM	NAME

LOCATION: See maps pages 3, 6, 7	EMPLACEMENT: Voir cartes pages 3, 6, 7	LAGE: Siehe Karten Seite 3, 6, 7
2-TRANSPORT required	VEHICULES nécessaires	Erforderlicher Transportraum

TRUCKS of	CAMIONS de	Lkw je

(No) (Anzahl)......................
Tons...................................

3-ROUTE: See maps pages 3, 6, 7	ITINERAIRE: Voir cartes pages 3, 6, 7	WEG: Siehe Karten Seite 3, 6, 7
4-Approximate travel DISTANCE from Prestock point to target	DISTANCE approximative entre centre de rattachement (prestockage) et dispositif.	Ungefahre ENTFERNUNG vom Munitionslagerplatz zum Objekt.

.... km

5-Explosives and stores required: see page 9	Explosifs et matériels nécessaires: Voir page 9	Erforderliche Sprengmittel u. Gerat. Siehe Seite 9
6-Storage location of additional barrier material	Lieu de stockage des accessoires de mise en oeuvre supplémentaires	Lagerort zusatzlicher Sperrmittel

MAP NAME AND SCALE	NOM ET ÉCHELLE DE LA CARTE	Kartenbezeichnung und Maßstab

GRID REFERENCE	COORDONNEES	KOORDINATEN

-6-

Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(2a) LOCATION OF PRESTOCK POINT	EMPLACEMENT DU DÉPÔT DE MUNITION	LAGE DES MUNITIONS-LAGERPLATZES

SAMPLE

(Map of Scale 1:50 000 showing location and route.)

(Carte au 50 000e renseignant sur l'emplacement et les accès.)

(Karte im Maßstab 1:50.000 mit Lage und Zufahrtsweg.)

SCALE	ÉCHELLE	Maßstab	1:50.000

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Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(2b) LAYOUT PLAN OF PRESTOCK POINT	PLAN DU DÉPÔT DE MUNITION	LAGEPLAN DES MUNITIONSLAGERPLATZES

(Sketch (scale about 1:5.000) showing entrances, route, storehouses (igloos) in which explosives and materials are stocked, etc.)

(Croquis (échelle de l'ordre de 1:5.000 montrant les entrées, circuits, magasins où matériels et explosifs sont stockés, etc.)

(Lageskizze (Maßstab 1:5.000) mit Eingängen, Straßen und Bunkern, in denen Spreng- und Zündmittel, Gerät usw. gelagert sind.)

SCALE	ÉCHELLE	Maßstab	1:5.000

-8-

Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(2c)

Instructions for opening ammunition storage vault door
Directives pour l'ouverture de la porte du dépôt de munitions
Anweisung für das Öffnen der Sperrmittelhaustür

Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfullen

Instructions for opening ammunition storage vault door
Directives pour l'ouverture de la porte du dépôt de munitions
Anweisung für das Öffnen der Sperrmittelhaustür
SAMPLE

-10-

Figure 4-3. Obstacle folder (continued)

Key for ammunition storage facility
Clefs pour la soute de munitions
Schlüssel fur das Munitionslagerhaus

The bearer of this document is authorised to enter the ammunition site and to pick up from Bunker No. ..... the barrier material for Target No. ..... .
Le titulaire du présent document est habilité à accéder au lieu de stockage des munitions et àprendre - dans la soute no. ..... - les accessoires nécessaires à la mise en oeuvre de l'obstacle no. ..... .
Der Inhaber dieses Dokuments ist berechtigt den Sperrmittellager-ort zu betreten und aus dem Bunker Nr. ... das Sperrmaterial für die Sperre Nr. ..... zu entnehmen.

If the keys are not kept in this obstacle folder their location is to be marked clearly here:
Si les clés ne seront pas conservées dans le présent carnet d'obstacles, indiquer ci-après l'endroit de conservation exact:
Werden die Schlussel nicht in diesem Sperrheft aufbewahrt, ist der genaue Ort hier anzugeben:

-11-

Figure 4-3 Obstacle folder (continued)

NATO-CONFIDENTIAL on completation
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN nach Ausfüllen

(2d) EXPLOSIVES, STORES MINES REQUIRED | EXPLOSIFS, MATERIELS MINES NECESSAIRES | BEDARF AN SPRENG- UND ZÜNDMITTELN GERÄT, MINEN

TARGET No	DISPOSITIF No	OBJEKT No	

PRESTOCK POINT	DEPOT DE MUNITION	MUNITIONS-LAGERPLATZ	

	ITEM (English)	DESIGNATION (Francais)	ART (Deutsch)	MENGE AMOUNT QUANITE	GESAMTGEWICHT TOTAL WEIGHT POINS TOTAL
(1)	(2)	(3)	(4)	(5)	(6) (kg)
1	EXPLOSIVES	EXPLOSIFS	SPRENGMITTEL		
a	Cratering charges	Expl. progressifs	Trichter sprengladungen		
b	High explosives	Expl. brisants	P-Sprengmittel Brisanzsprengst		
c	Plastic explosives	Plastique	Sprengmasse formbar		
d	Shaped charges	Charges creuses	Hohlladungen		
e	Cutting charges	Charges coupantes	Schneid-ladungen		
2	ACCESSOIRES	ARTIFICES	ZÜNDMITTEL		
a	Safety Fuze	Meche lente	Anzündschnur		
b	Detonating cord	Cordeau détonant	Sprengschnur		
c	Non elec-tric Detonators	détonateurs pyro techni-que	Spreng-kapseln		
d	Electric Detonators	détonateurs electrique	Sprengkapseln elektrisch		
e	Prime cap	Détonateur d'amorce	Sprengkapsel-zünder		
f	Booster cap	Renforca-teur	Sprengschnur-kapsel		
g	Blasting machine (exploder)	Exploseur	Zünd-maschine		
h	Cable elec-tric (2 wire)	Cable elec-trique (2 fils)	Zündkabel (zweiadrig)		

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SAMPLE

Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfullen

(1)	(2)	(3)	(4)	(5)	(6)
3	TOOLS	OUTILLAGE	WERKZEUG		
a	Quarrying bars	Barres a mine	Brech-stangen		
b	Shovels	Pelles	Schaufeln		
c	Picks	Pioches	Kreuzhacken		
d	Saws	Scies	Sägen		
4	STORES	MATERIEL	GERÄT		
a	Nails	Pointes	Nägel		
b	Wire	Fil de fer	Draht		
c	Timber	Planches	Bohlen		
5	MINES	MINES	MINEN		
a	Mines AP	Mines AP	SchAbwMi		
b	Mines AT	Mines AC	PzAbwMi		
c	Fuzes	Allumeurs	Zünder(Minen)		
	TOTAL WEIGHT	POIDS TOTAL	GESAMTGEWICHT		

SAMPLE

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Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(2d) EXPLOSIVES, STORES MINES REQUIRED | EXPLOSIFS, MATERIELS MINES NECESSAIRES | BEDARF AN SPRENG- UND ZÜNDMITTEL, GERÄT, MINEN

TARGET No.	DISPOSITIF No	OBJEKT No	

PRESTOCK POINT	DÉPÔT DE MUNITION	MUNITIONS-LAGERPLATZ	

	ITEM (English)	DESIGNATION (Francais)	ART (Deutsch)	MENGE AMOUNT QUANTITE	GESAMTGEWICHT TOTAL WEIGHT POIDS TOTAL
(1)	(2)	(3)	(4)	(5)	(6) (kg)
1	EXPLOSIVES	EXPLOSIFS	SPRENGMITTEL		
a	Cratering charges	Expl. progressifs	Trichter-sprengladungen		
b	High explosives	Expl. brisants	Pi-Sprengmittel Brisantsprengm.		
c	Plastic explosives	Plastique	Sprengmasse Formbar		
d	Shaped charges	Charges creuses	Hohlladungen		
e	Cutting charges	Charges coup.	Schneid-ladungen		
2	ACCESSORIES	ARTIFICES	ZÜNDMITTEL		
a	Safety Fuze	Meche lente	Anzündschnur		
b	Detonating cord	Cordeau détonant	Sprengschnur		
c	Non electric Detonators	détonateurs pyrotechnique	Sprengkapseln		
d	Electric Detonators	détonateurs electrique	Sprengkapseln elektrisch		
e	Prime cap	Détonateur d'amorce	Sprengkapsel-zünder		
f	Booster cap	Renforçateur	Sprengschnur-kapsel		
g	Blasting machine (exploder)	Exploseur	Zünd-maschine		
h	Cable electric (2 wire)	Cable electrique (2 fils)	Zündkabel (zweiadrig)		

SAMPLE

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Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(1)	(2)	(3)	(4)	(5)	(6)
3	TOOLS	OUTILLAGE	WERKZEUG		
a	Quarring bars	Barres a mine	Brech-stangen		
b	Shovels	Pelles	Schaufeln		
c	Picks	Pioches	Kreuzhacken		
d	Saws	Scies	Sägen		
4	STORES	MATERIEL	GERÄT		
a	Nails	Pointes	Nägel		
b	Wire	Fil de fer	Draht		
c	Timber	Planches	Bohlen		
5	MINES	MINES	MINEN		
a	Mines AP	Mines AP	SchAbwM.		
b	Mines AT	Mines AC	PzAbwM.		
c	Fuzes	Allumeur	Zünder(Minen)		
	TOTAL WEIGHT	POIDS TOTAL	GESAMTGEWICHT		

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Figure 4-3. Obstacle folder (continued)

VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen
NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie

(3) DEMOLITION ORDER and/or MINEFIELD RECORD
do not complete until after laying the minefield

ORDER DE MISE DE FEU et/ou FEUILLE DE RENSEIGNEMENTS
á completer aprés réalisation de champ de mines

SPRENGBEFEHL und/oder MINENSPERRNACHWEIS
erst nach dem Anlegen der Minensperre vollständig ausfüllen

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Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTREULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(3a) SPECIAL TECHNICAL INSTRUCTIONS	CONSIGNES TECHNIQUES PARTICULIERES	TECHNISCHE EINZELANWEISUNGEN
1. Time required for preparing and charging	Temps nécessaire pour préparation chargement	Zeitbedarf für die Vorbereitung zur Sprengung

Hours	Heures	Std	Min

2. Time required for passing from state of readiness 1 (SAFE) to 2 (ARMED)	Temps nécessaire pour passer de l'état de préparation 1 (NON AMORCE) à 2 (AMORCE)	Zeitbedarf für Änderung der Zündbereitschaft vom 1 (GESICHERT) in 2 (ENTSICHERT)

Min

3. Personnel required for preparing and charging	Personnel nécessaire pour préparation et chargement	Personalbedarf für die Vorbereitung zur Sprengung

N.C.O.	S/Officier	Uffz	....
Men	Hommes	Mannsch.	....

4. Personnel required for firing	Personnel nécessaire pour mise de feu	Personalbedarf für Zündtrupp

N.C.O.	S/Officier	Uffz	....
Men	Hommes	Mannsch.	....

5. Organization of work (attached if necessary)	Organisation du chantier (si nécessaire)	Arbeitsplan falls erforderlich
6. Drawings and sketches See page 13, 14	Plans et croquis Voir pages 13, 14	Zeichnungen und Skizzen Siehe Seite 13, 14

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Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion

OTAN-CONFIDENTIEL une fois remplie

VS-VERTRAULICH
AMTLICH GEHEIMGEHALTEN

nach Ausfüllen

MINES	MINES	MINEN
(a) Nuisance mines + MUST be laid + MUST NOT be laid + See sketch page 17 (b) THERE IS + A large THERE IS + NO minefield near (give location and reference of minefield record).	Les mines de harcèlement + DOIVENT + NE DOIVENT PAS être posées + Voir croquis page 17 + IL EXISTE + IL N'EXISTE PAS un champ de mines important à proximité (indiquer l'emplacement et documents de référence)	+ MÜSSEN verlegt werden + MÜSSEN NICHT verlegt werden + Siehe Skizze Seite 17 + ES IST EINE + ES IST KEINE größere Minensperre in der Nähe (Angaben über Lage und diesbezüglichen Minensperrnachweis)
+ Strike out words not applicable	+ Rayer la mention inutile	+ Nicht Zutreffendes streichen

English Translation of notes on the sketch page 14	Français Traduction des inscriptions portées sur le croquis page 14	Deutsch Übersetzung der Anmerkungen auf der Skizze Seite 14	

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Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(3b) SKETCH OF TARGET	CROQUIS DE L'OUVRAGE	TRENN-SCHNITT-SKIZZE

(Plan and sections of the target showing lines of cut and demolition chambers (in one language only))

Plan et coupes de l'ouvrage montrant sections de rupture et fourneaux (inscriptions en une seule langue))

(Zeichnung und Teilzeichnung mit Angabe der Trennschnitte und Sprengkammern (nur in einer Sprache))

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Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

English Translation of notes on the sketch page 15	Francais Traduction des inscriptions portées sur le croquis page 15	Deutsch Übersetzung der Anmerkungen auf der Skizze Seite 15	

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Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(3c) SKETCH OF CHARGES	CROQUIS DE CHARGEMENT	LADUNGS-SKIZZE

(Plans and sections showing details of chambers, lines of cut and location of charges, giving quantities of explosives, method of ignition etc. (in one language only))

(Plans et coupes détaillés des fourneaux, profils de rupture, emplacement des charges, avec indication des quantités d'explosifs, amorçage, et inscriptions en une seule langue))

(Zeichnung und Teilzeichnung mit Sprengkammern, Trennschnitten, Ladungsanbringung mit Angabe der Ladungsmenge und Zündungsart (nur in einer Sprache))

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Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

English Translation of notes on the sketch page 16	Francais Traduction des inscriptions portées sur le croquis page 16	Deutsch Übersetzung der Anmerkungen auf der Skizze Seite 16	

SAMPLE

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Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(3d) SKETCH OF IGNITION SYSTEM	SCHEMA DE LA MISE DE FEU	ZÜNDLEITUNGS-SKIZZE

(Sketch showing firing circuits and firing point (in one language only))

(Croquis montrant les circuits de mise de feu et le point de mise de feu (inscription en une seule langue))

(Skizze der Zündleitungen (Haupt- und Reserveleitung) und der Zündstelle (nur in einer Sprache))

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Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(3e) MINE FIELD IF APPLICABLE, OR PROTECTIVE MINES	CHAMP DE MINES OU CHAMP DE MINES DE PROTECTION SUIVANT LE CAS	MINENSPERRE FALLS VOR-HANDEN ODER SICHERUNGS-MINENSPERRE
Personnel and time required for laying mines	Personnel et temps nécessaire pour la pose des mines	Kräfte u. Zeitbedarf f. das Verlegen von Minen

Men	Hommes	Mann		Hours	Heures	Std	Min

Sketch of the planned minefield.
When laid draw sketch on page 20
and fill out minefield record
(page 11).

Croquis du champ de mines prévu.
Si réalisé inscrire à la page 20 et
remplir la feuille de renseignements
(page 11).

Skizze der geplanten Minensperre.
wenn angelegt auf Seite 20 eintragen
und Minensperrnachweis ausfüllen
(Seite 11).

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Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(4a)

TURN-OVER/TAKE-OVER OF TARGET		Target No.	
REMISE/REPRISE DU DISPOSITIF		Dispositif No.	
ÜBERGABE/ÜBERNAHME DER SPERRE		Objektnummer	

Type of target
Type d'obstacle
Art der Sperre

Grid reference		Date/Time Group	
Coordonnées UTM		Groupe date/heure	
UTM-Koordinaten		Datum/Zeit-Gruppe	

State of readiness at time of turn-over/take-over	
Etat de préparation au moment de la remise	
Zündbereitschaft bei Übergabe/Übernahme	

Work still required to complete barrier or to prepare demolition target
Traveaux restant à effectuer jusqu' à l'achèvement
Noch auszuführende Arbeiten bis zur Fertigstellung

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Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

Ammunition/equipment to be turned-over/taken-over
Munition, matériels à remettre
Zu übergebende/übernehmende Munition/Gerät

Barrier doccumentation will remain at:
Les documents seront gardés par:
Sperrunterlagen verbleiben:

Relieved Commander
Responsable de la remise
Übergebender

Last name Nom Name		Rank Grad Dienstgrad	
Unit Unité Einheit		Signature Signature Unterschrift	

Relieving Commander
Responsable de la reprise
Übernehmender

Last name Nom Name		Rank Grad Dienstgrad	
Unit Unité Einheit		Signature Signature Unterschrift	

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Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(b)

TURN-OVER/TAKE-OVER OF TARGET	Target No.	
REMISE/REPRISE DU DISPOSITIF	Dispositif No.	
UBERGABE/UBERNAHME DER SPERRE	Objektnummer	

Type of target
Type d'obstacle
Art der Sperre

Grid reference		Date/Time Group	
Coordonnées UTM		Group date/heure	
UTM-Koordinaten		Datum/Zeit-Gruppe	

Relieved Commander
Responsable de la remise
Uebergebender

Last name		Rank	
Nom		Grad	
Name		Dienstgrad	
Unit		Signature	
Unité		Signature	
Einheit		Unterschrift	

Relieving Commander
Responsable de la reprise
Übernehmender

Last name		Rank	
Nom		Grad	
Name		Dienstgrad	
Unit		Signature	
Unité		Signature	
Einheit		Unterschrift	

Copy for the unit handing over.

Exemplaire pour l'unité remettante.

Ausfertigung für die übergebende Einheit.

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Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(5)	DEMOLITION REPORT	COMPTE RENDU DE DESTRUCTION	MELDUNG ÜBER DURCHGEFÜHRTE SPRENGUNG	
a.	TARGET NO.	DISPOSITIV NO.	Objekt Nr	
b.	MAP REFERENCE	COORDONNÉES	KOORDINATEN	
c.	Demolition was fired at	La mise de feu a été faite à	Die Sprengung erfolgte	
	Date-Time	Date-heure	Datum-Zeit	
	....	....	....	....
d.	Extent of damage (1) In case of a bridge	Résultats obtenus (1) Cas d'un pont	Umfang der Zerstörungen (1) im Falle einer Brücke	
	Width of gap .... meters	Largeur de brèche .... mètres	Weite der Unterbrechung . ... m	
	NO. of spans down	No. de travées détruites	Anzahl der herabgefallenen Strecken	
	(2) In a road or runway size, depth and location craters:	(2) Sur une route ou piste: Dimensions, profondeur et emplacement des entonnoirs:	(2) Auf einer Straße oder Rollbahn: Große, Tiefe und Lage von Trichtern	
	(3) Mines laid, type and number	(3) Mines posées, type et nombre	(3) Anzahl und Art verlegter Minen	
	(4) Any other details	(4) Autres renseignements	(4) Sonstige Anmerkungen	

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Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

(5) SKETCH showing effect of demolition and location of mines (if applicable)	(5) CROQUIS montrant les effets de la destruction et emplacement du champ de mines (s'il y a lieu)	(5) Skizze über das Ausmaß der Zerstörungen und Lage der Minen (wenn verlegt)

date-time	date-heure	Datum-Zeit

Name	Nom	Name	Rank	Grade	Dienstgrad	Unit	Unité	Einheit

TO	DESTINATAIRE	AN

Signature	Unterschrift

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Figure 4-3. Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH
AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

TABLE OF CONTENTS

TABLE DE MATRES

INHALTSVERZEICHNIS

Figure 4-3 Obstacle folder (continued)

NATO-CONFIDENTIAL on completion
OTAN-CONFIDENTIEL une fois remplie
VS-VERTRAULICH AMTLICH GEHEIMGEHALTEN
nach Ausfüllen

Notes:

1. Pages 3; 7-12; 14 can be detached from the target folder and handed to the soldier detailed to pick up the barrier material.
2. The commander of the closing/executing unit will use pages 29/30 to report the results to his immediate superior.

Remarques:

1. Les pages 3; 7-12;14 peuvent être retirées du carnet de dispositif de destruction preparée et remises au responsable de l'enlèvement des explosifs.
2. Le chef du détachement de protection/de mise à feu emploiera les pages 29/30 pour faire rapport à son chef immédiat.

Anmerkungen:

1. Die Seiten 3; 7-12;14 können dem Sperrheft entnommen und dem Soldaten übergeben werden, der die Sperrmittel abholt.
2. Das Ergebnis ist vom Führer der schließenden/auslösenden Einheit/Teileinheit mit Seite 29/30 an den unmittelbaren Vorgesetzten zu melden.

TARGET folder completed by — CARNET d'[illegible] établi par — Sperrheft aufgestellt durch:

Name	Nom	Name	Rank	Grade	Dienstgrad	Designation	Fonction	Dienststellung

Signature	Unterschrift

Date	Datum

Name	Nom	Name	Rank	Grade	Dienstgrad	Designation	Fonction	Dienststellung

Signature	Unterschrift

Date	Datum

Folder reviewed by — Carnet controlé par — Sperrheft geprüft

Name	Rank	Designation	Date	Signature

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Figure 4-3. Obstacle folder (continued)

TECHNIQUES COMMON TO MOST DEMOLITIONS

Types of Military Demolitions

There are three types of demolitions applicable to tactical situations—reserved, deliberate, and hasty.

Reserved demolitions. Reserved demolitions are specifically controlled at a command level appropriate to the tactical or strategic plan. Reserved demolitions are usually in place, ready and waiting, and in the safe condition.

Deliberate demolitions. Use deliberate demolitions when enemy interference during preparations is unlikely and there is enough time for thorough reconnaissance and careful preparation. Deliberate preparation permits economy in the use of explosives since time allows accurate calculation and positive charge placement to obtain the effects required.

Hasty demolitions. Use hasty demolitions when time is limited and economy of explosives is secondary to speed. In all cases, use common sense and good judgment to prevent waste. Give a priority to each charge in the preparation of demolition projects in forward areas where a surprise raid by hostile forces is possible. Although this procedure is relatively time-consuming, it causes maximum damage in relation to the time required even though enemy interference might prevent completion of the job. Prime each charge as it is placed. If charges are all placed first and then primed, enemy interference prior to the act of priming might stop the work before any damage is done. The use of dual detonating cord ring main lines and branch lines is recommended for all front-line demolition projects.

Nuclear Weapons Demolitions

Use atomic demolition munitions (ADMs) to create obstacles and deny entry to military facilities or installations. Atomic demolition munitions have the capability of creating large radioactive craters with little preparatory effort. The residual radiation and fallout hazards require consideration. However, the use of small yields minimizes the fallout hazard and area of residual contamination. The ADM, like a conventional hand-placed charge, has a primary advantage over ballistic-delivered explosives, thus permitting the use of minimum yield for a given target. For additional information, see FM 5-106.

Supplements to Demolition Obstacles

Nuisance mining and charges with delay fuzes are very potent means of increasing the effects of demolition projects. In the map of the area to be mined, include the facility to be destroyed, the ground where a replacement structure could be built or remedial work done, and a replacement structure could be built or remedial work done, and working party bivouac and alternate sites. For a demolished bridge, mine the dropped spans and abutments to prevent removal or recovery. Mine a suitable site for a floating bridge or ford to prevent ready use. Mine and booby trap locations likely to be selected for material storage, equipment parks, or bridge unit bivouacs. For additional information, see FM 20-32.

BRIDGE DEMOLITION

Extent of Demolition

There is no rule of thumb or regulation to indicate how much of a bridge to destroy in a given situation. Determine the extent of demolition after an analysis and investigation of specific conditions.

Complete bridge demolition. Complete demolition leaves nothing of the old bridge suitable for use in a new bridge. Leave the debris on the site where its removal will require hazardous work before any kind of crossing can be installed. However, even a partial demolition may be enough to force the enemy to seek a new site for a temporary bridge to substitute for the damaged bridge. Further demolition is then unnecessary. A permanent structure is not likely to be replaced during wartime. However, where the terrain is such that the current bridge site is needed for a new structure, even a temporary one, demolition of greater proportions may be justified.

Partial demolition. Bridges are usually demolished to create obstacles that delay the enemy. This purpose seldom requires complete destruction. Unless a denial operation is in effect, the demolition method chosen—near side spans and abutments—should permit economical reconstruction of the bridge by friendly troops at a later date.

Obtain the necessary delay by only blasting a gap too long to be spanned by the prefabricated bridging available to the enemy. Locate this gap where the construction of an intermediate support is difficult or impossible. A high and relatively slender bridge component can be demolished by cutting one side so that it topples into a mass of broken and twisted material. The destruction of massive bridge components, however, requires large expenditures of explosive, time, equipment, and effort that may not be profitable. Often on major bridges, the destruction of a component that can easily be replaced may not be justified.

Factors determining the extent of bridge destruction are the same as those listed in Chapter 4, Demolition Planning.

Plans for Bridge Demolitions

Structural characteristics. Plan the demolition of bridges carefully. There are many types of bridges which have a great variety of superstructures and substructures made of steel, timber, or masonry. The size and placement of the charge depends on the traits of the individual bridge structure.

General procedures. Some general procedures apply to most bridge demolition projects. For example, if charges are placed under the bridge roadway, take special precautions to ensure that the charges will not be shaken loose or initiated by traffic on the bridge. The general points outlined here apply to the demolition of most or all of fixed, movable, and floating bridge structures.

Place hasty charges first because of possible enemy interruption. Locate them carefully so that if possible they can be included later into the deliberate preparation of the bridge.

Blasting several times rather than only once is often preferred. This saves on the use of explosives and can improve the thoroughness of the demolition. Consider this procedure when conditions permit.

Give tension members priority because they are harder to repair than compression members. Tension members almost always require steel riveting or welding, while compression members can sometimes be replaced by cribbing.

When bridges over railways or canals are to be destroyed, plan the demolition so any temporary intermediate piers that might be erected to repair the structure will be located where they will block traffic on a railroad or canal.

Any long steel members that require cutting in only one place to demolish the bridge should be further damaged to prevent their ready salvage by recutting or splicing. It is not necessary to cut such members completely at other points to accomplish this. Locate a number of small charges properly to damage the upper flange, the lower flange, and the web. This will make repair difficult and uneconomical. Consider the twisting of such members in dropping the span and any other feasible method of further destruction.

The nature of the terrain under the bridge is of great importance to the success of the demolition For example, if the distance from the riverbed to the bridge is adequate, the weight of the bridge can be used to assist in its destruction.

Types of Bridges

Bridges can be classified in many different ways. For the purpose of planning and executing bridge demolitions, bridges are grouped into three general types—fixed bridges, movable bridges, and floating bridges.

Fixed bridges. Fixed bridges are those in which a rigid and nonmovable superstructure is supported on solid and nonmovable supports. Fixed bridges are the most common types of bridges.

Movable bridges. Movable bridges are those in which a portion of the bridge is capable of being moved to allow waterborne traffic to pass the bridge.

Floating bridges. Floating bridges are those with a roadway supported by floats or pontons. This type of bridge is usually constructed by military forces and used as a temporary bridge until a fixed or movable bridge is completed or repaired.

Parts of Bridges

The ordinary bridge is divided into two main parts—the lower part (or substructure) and the upper part (or superstructure) (Figure 4-4).

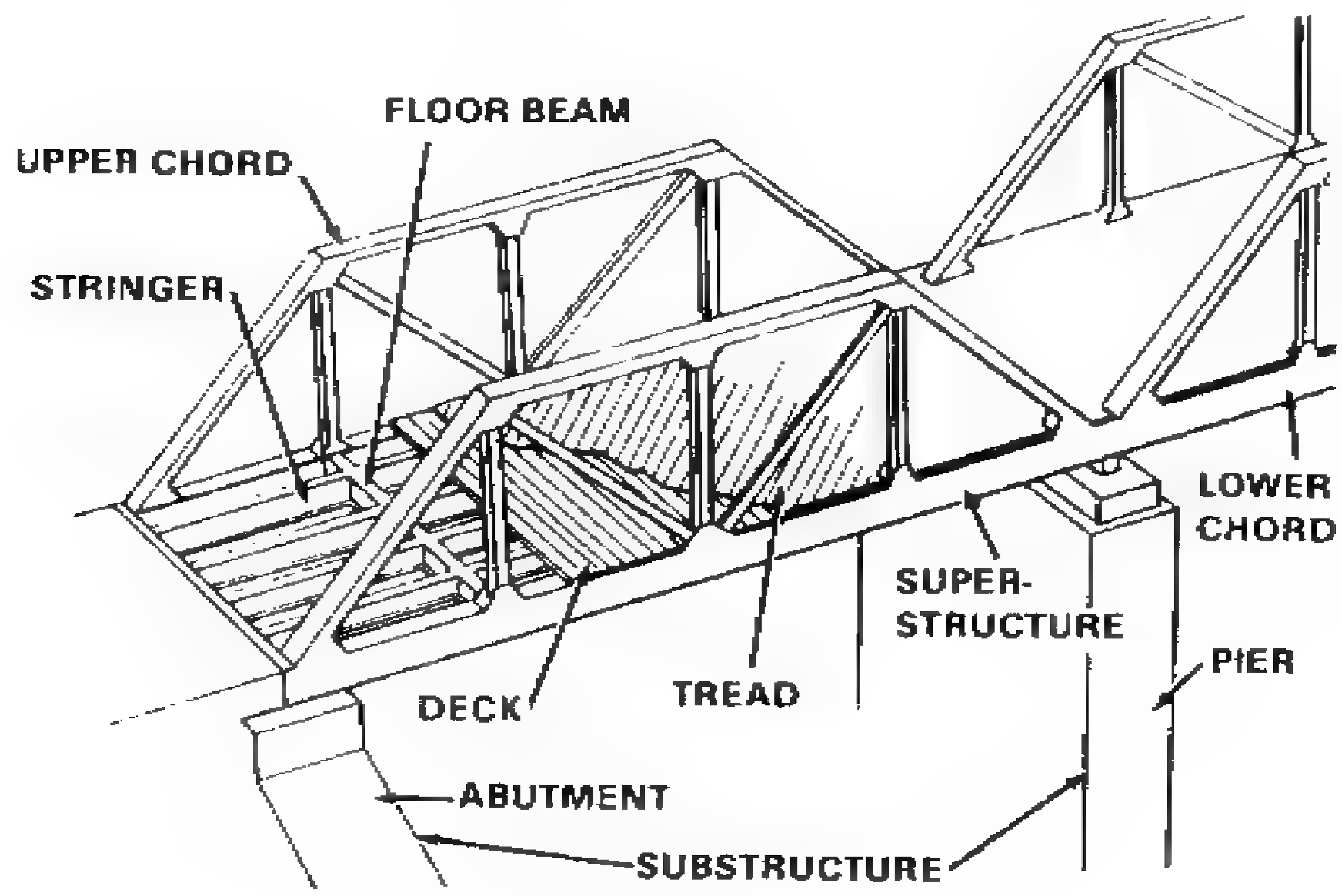


Figure 4-4. Parts of a bridge

Substructure. The substructure consists of the parts of a bridge that support the superstructure. There are two kinds of supports—end supports (or abutments) and intermediate supports (or piers or bents). The parts of the substructure are abutments, footings, end dams, intermediate supports, and pontons.

Abutments are ground supports located at both ends of a bridge. They can be constructed of concrete, masonry, steel, or timber and can include retaining walls or an end dam.

A *footing* is that part of any bridge support that rests directly on the ground. It distributes the load over an area wide enough to keep the support from sinking into the ground.

An *end dam* is a retaining wall of concrete, wood, or other material at the end of a bridge. The end dam supports the bank and keeps the approach road from caving in.

An *intermediate support* is a support placed beneath a bridge between the abutments. It may be a pier of masonry or concrete, cribbing, several piles or trestle bents constructed as a unit, or a single pile or trestle bent.

A *ponton* is an intermediate support which floats on the water. It is found in floating bridges.

Superstructure. The superstructure includes the stringers, any girders or trusses, floorings, and floor beams that make up the total part of the bridge above the substructure (Figure 4-4).

Stringers are members that run lengthwise with the bridge and directly support the deck.

Girders are two large stringers which run lengthwise and are the main load-carrying members.

Trusses are built-up members which are load-carrying members of the superstructure and consist of these principal parts—the lower, upper, and intermediate chords.

The *lower chord* is the lower member in a truss panel. It runs parallel to the deck.

The *upper chord* includes the upper members in a truss panel.

The *intermediate chords* or diagonals are the members between the upper and lower chords.

The flooring consists of two parts the deck and the tread. The *deck* is the floor of the bridge. The *tread* is the top surface material.

Destruction of Substructures

Concrete and masonry abutments. Placing charges in the fill behind an abutment has the advantages of economy in the use of explosives and concealment of the charges from the enemy until they are detonated. The disadvantage of this method is that the charges are difficult to place.

Where speed is required, do not place charges behind the abutment if the fill is known to contain large rocks.

Demolish abutments 5 feet or less in thickness by a line of 40-pound cratering charges placed on 5-foot centers in holes 5 feet deep and 5 feet behind the face of the abutment (*triple-nickel-forty*). Place the first hole 5 feet from either edge of the abutment and continue this spacing until a distance of 5 feet or less is left from the last hole to the other side of the abutment. If the bridge approach is an embankment, place the explosive charges in a tunnel dug into the side of the embankment. Compute the number of charges by using the following formula:

$$N = \frac{W}{5} - 1, \text{ where}$$

N = number of charges and

W = width of the abutment, in feet. (14)

If the wing walls are strong enough to support a rebuilt or temporary bridge, destroy them by placing charges behind them in the same way (Figure 4-5).

Demolish abutments more than 5 feet thick by placing breaching charges in contact with the back of the abutment. The breaching radius is the thickness of the abutment. Place the charges at a depth equal to the breaching radius (Figure 4-6).

Demolish abutments over 20 feet high by placing a row of breaching charges at the base of the abutment on the river face in addition to the charges above. Fire all charges simultaneously.These fill charges can be breaching charges as explained above or the *triple-nickel-forty* charges, depending on the abutment thickness. This method tends to overturn and completely destroy the abutment.

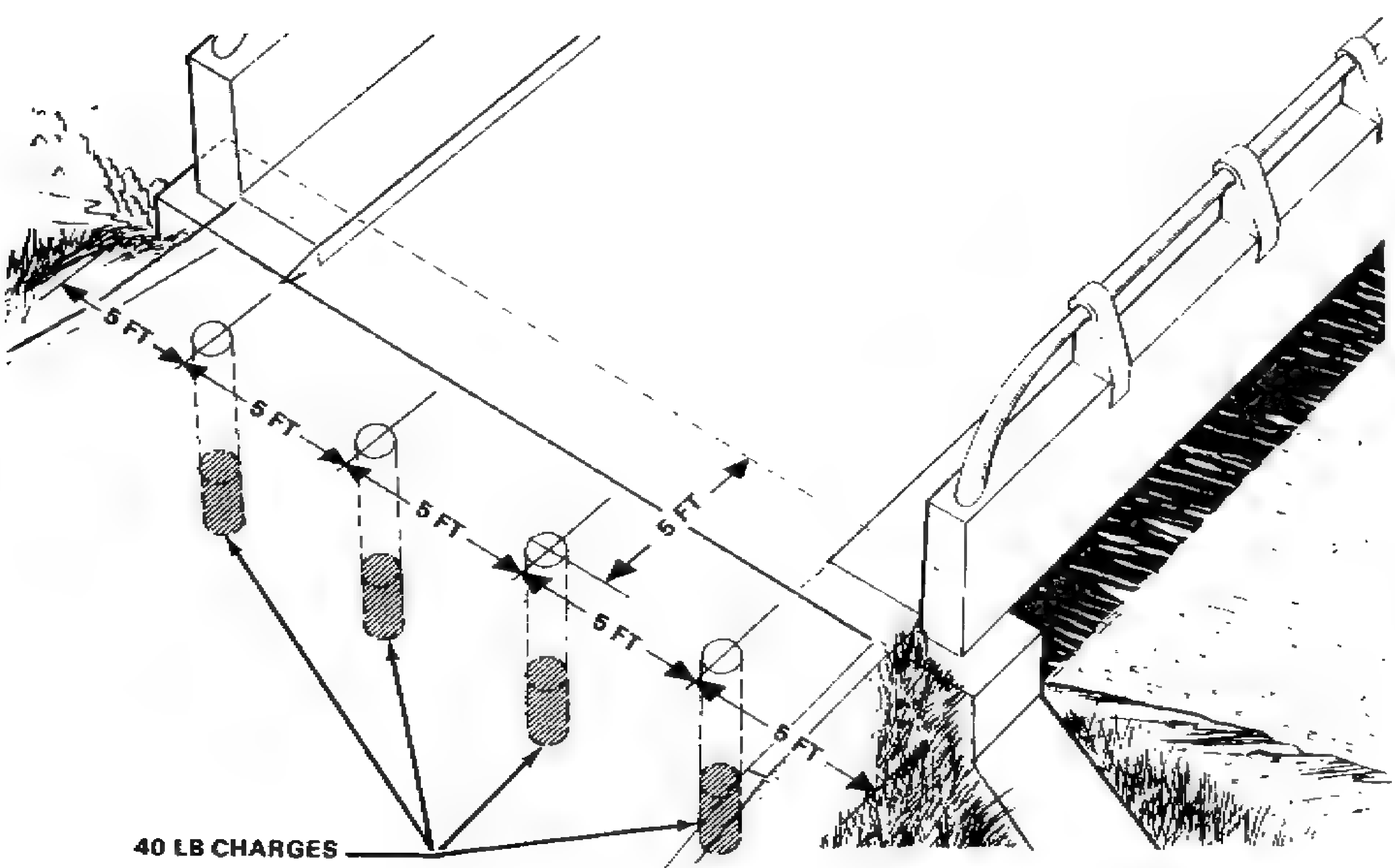


Figure 4-5. Destruction of abutment 5 feet thick or less

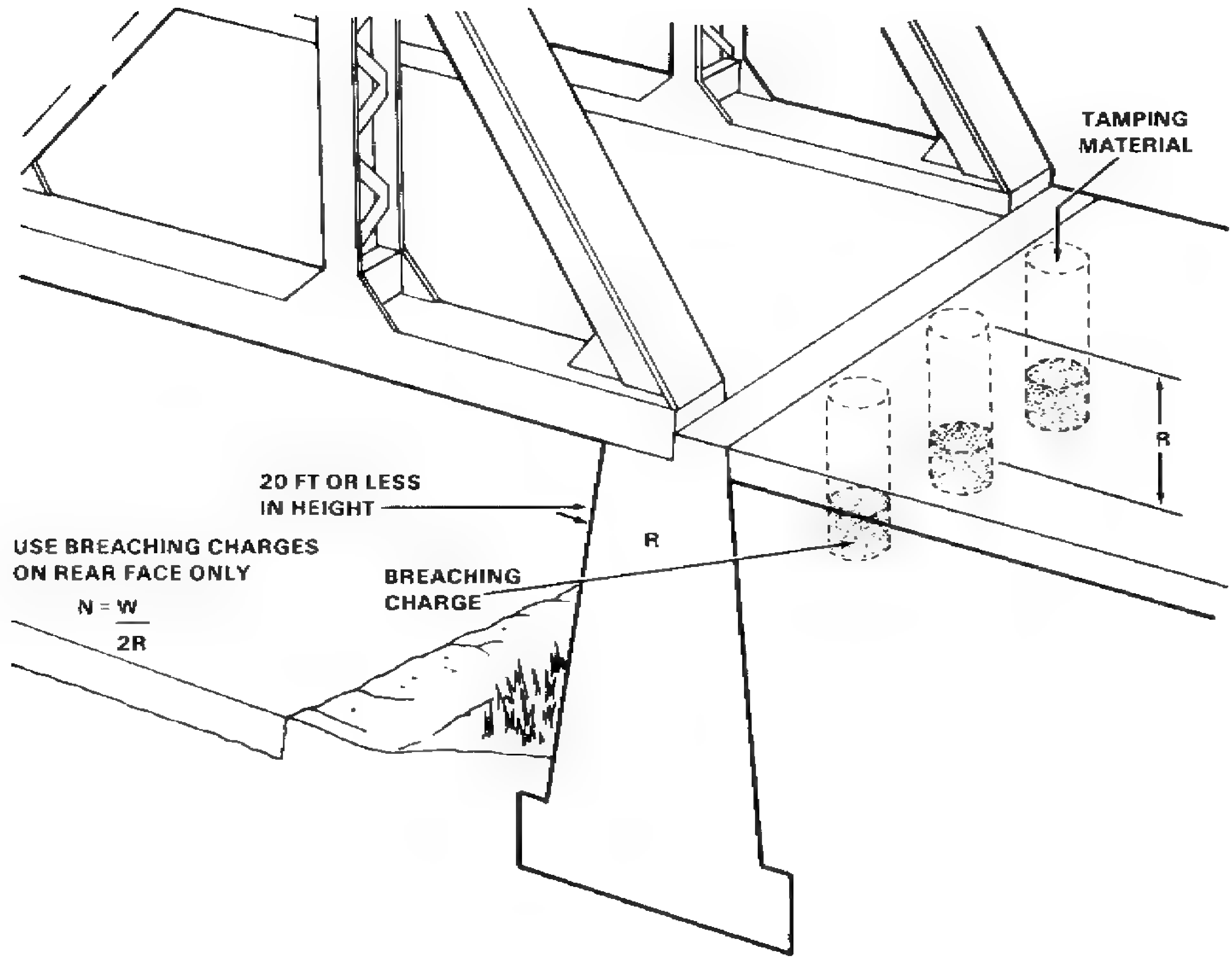


Figure 4-6. Destruction of abutment more than 5 feet thick

Calculate the breaching charges by using the breaching formula $P = R^3KC$ given in Equation (10). Use the abutment thickness at the charge location as the breaching radius R. Place the charges at a depth equal to or greater than R. Determine the number of charges and their spacing by the formula $N = \frac{W}{2R}$ given in Equation (11).

Intermediate supports. An effective method of demolition is the destruction of one or more intermediate supports of a multispan bridge (Figure 4-7). The destruction of one support will collapse the span on each side of it. Therefore, destruction of only alternate intermediate supports is enough to collapse all spans. Repair will require either the replacement of those supports or the construction of long spans.

Concrete and masonry piers. Demolish concrete and masonry piers by internal or external charges (Figure 4-7). Internal charges require fewer explosives than external charges, but because they require a great amount of equipment and preparation time, they are seldom used unless explosives are scarce or the pier has built-in demolition chambers. Calculate the number of charges by the formula $P = R^3KC$ given in Equation (10).

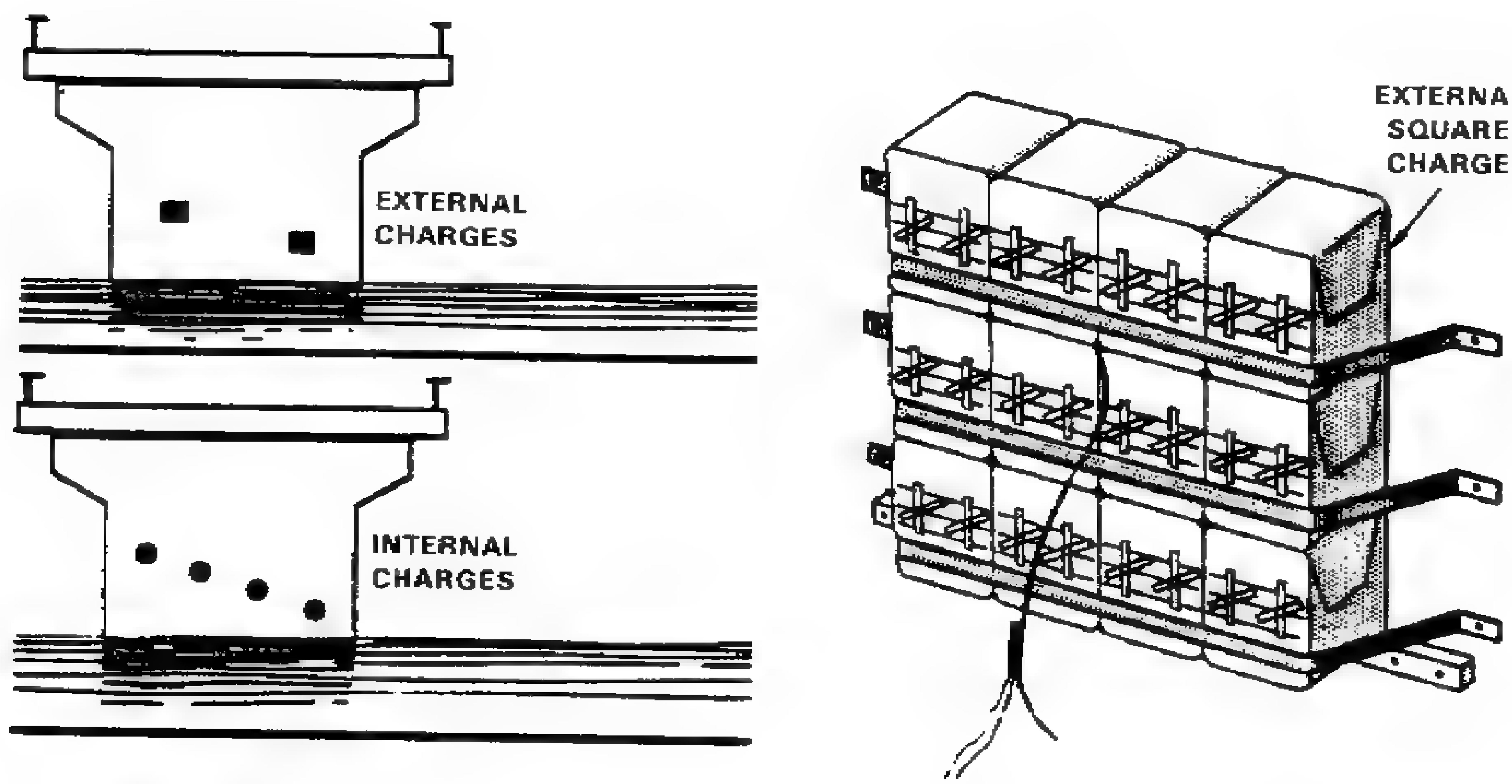


Figure 4-7. Charges placed on intermediate supports

Plastic (C4), dynamite, and other explosives are satisfactory for internal charges. Tamp all charges of this type thoroughly with blunt wooden tamping sticks. Do **not** use steel bars or tools. If there are no demolition chambers, place charges in boreholes blasted by means of shaped charges or drilled with pneumatic or hand tools. A 2-inch-diameter borehole holds approximately 2 pounds of explosive per foot of depth. The steel reinforcing bars, however, make drilling in heavily reinforced concrete impractical.

Place external charges at the base of a pier or higher, and space them not more than twice the breaching radius apart. Charges should be staggered to create an uneven surface to hinder future enemy use. Tamp all external charges thoroughly with earth and sandbags if time and the size, shape, and location of the target permits.

Destruction of Superstructures

In the destruction of bridge superstructures, the material that the load-bearing members are made of is as important as the type of superstructure. The material used often determines the types of superstructures that can be built. The methods for destruction or cutting of the most common types of superstructures follow.

Timber-Stringer Superstructures

Characteristics. Timber-stringer bridges are used extensively in the theater of operations for short-span crossings or in multiples of short spans for longer crossings. These bridges are constructed and used by the military. The stringers may consist of native timber logs or cut, dimensioned timber. The spans are simply supported and rarely exceed 20 feet. The deck is either plank or laminated timber decking. Some civilian bridges have asphalt or concrete wearing surfaces.

Method of demolition. Cut timber-stringer superstructures by placing timber-cutting charges to cut each stringer as shown in Figure 4-8.

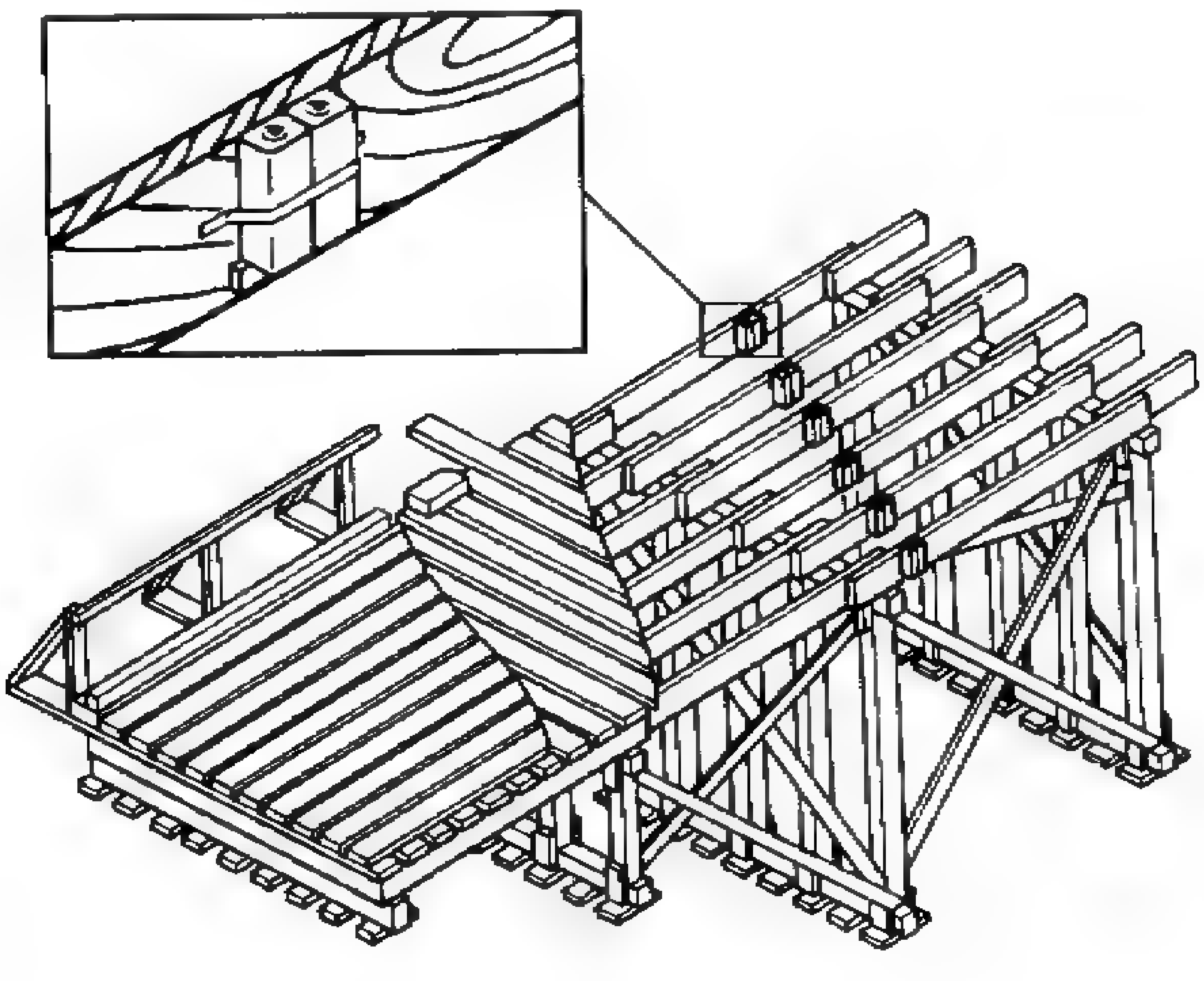


Figure 4-8. Demolition of timber-stringer superstructures

Steel-Stringer Superstructures

Characteristics. Steel stringers are used in simply supported spans up to 90 feet and in continuous-span bridges with clear spans up to 120 feet. The nonstandard steel-stringer bridge is constructed in the theater of operations by the military. Most civilian steel-stringer bridges constructed since the mid-1950s use high-strength steel and concrete and improved design techniques. Steel stringers consist of rolled shapes in spans up to 90 feet and beams built with welded steel plates in the 60- to 120-foot-span range.

Method of demolition. Cut steel-stringer superstructures by placing steel-cutting charges to cut each stringer, as shown in Figure 4-9.

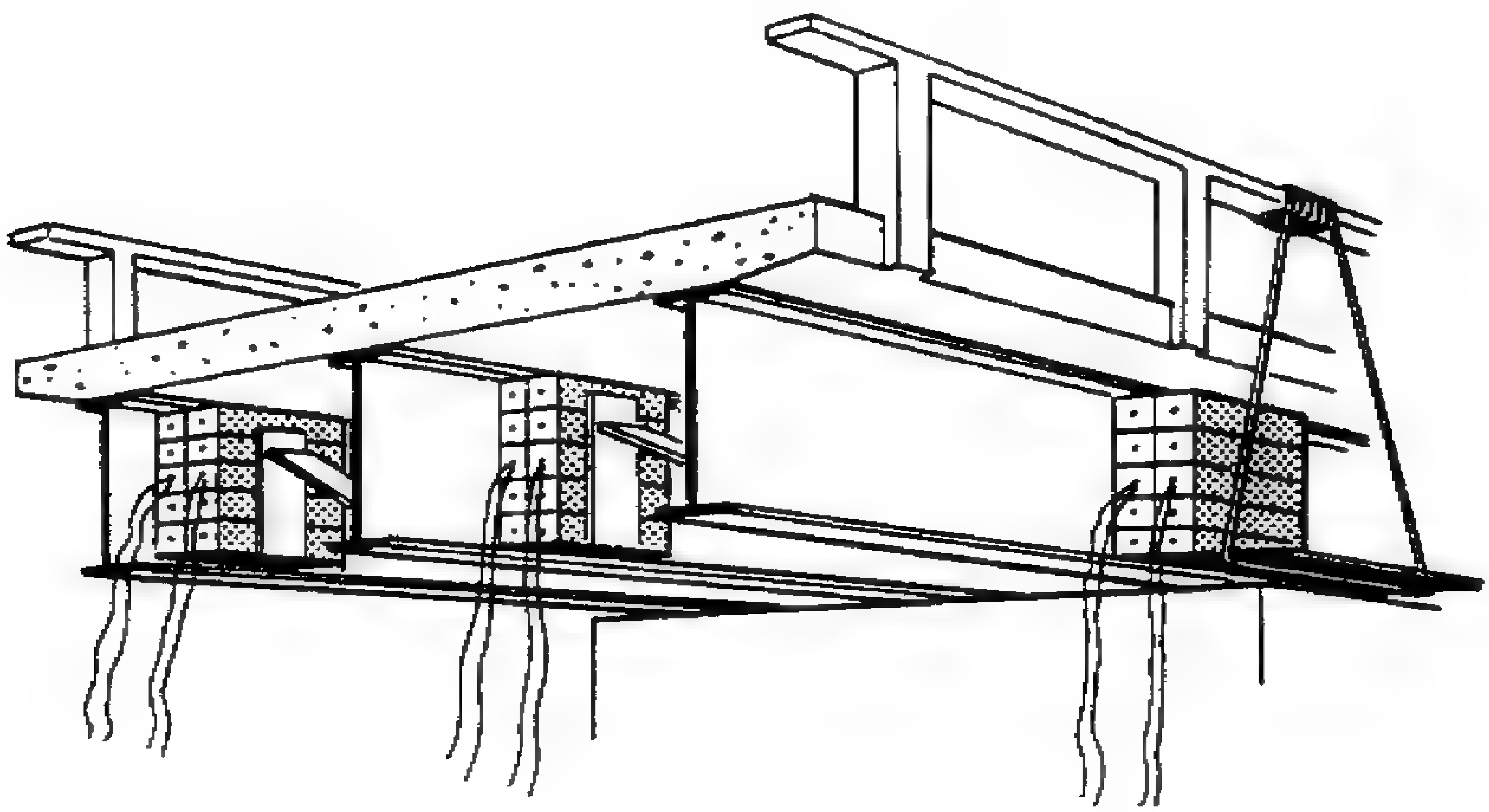


Figure 4-9. Demolition of steel-stringer superstructures

Composite-Steel-Concrete Stringers

Characteristics. In the early 1960s, an efficient method was developed to connect the reinforced-concrete deck to the top flange of steel stringers. In steel-stringer bridges, the concrete deck serves only to distribute the live load to the stringers. When the deck and stringer are structurally connected, a composite-steel-concrete beam is formed. The concrete deck increases the compression flange of the stringer. Composite-beam bridges are difficult to recognize or distinguish from normal steel-stringer bridges. All steel-stringer concrete-deck bridges with more than 60 feet of clear span constructed after the mid-1960s can be assumed to be composite-beam bridges.

Method of demolition. Cut composite-steel-concrete-stringer superstructures by placing steel-cutting charges and concrete-breaching charges to cut each steel stringer and breach the concrete deck above each stringer as shown in Figure 4-10.

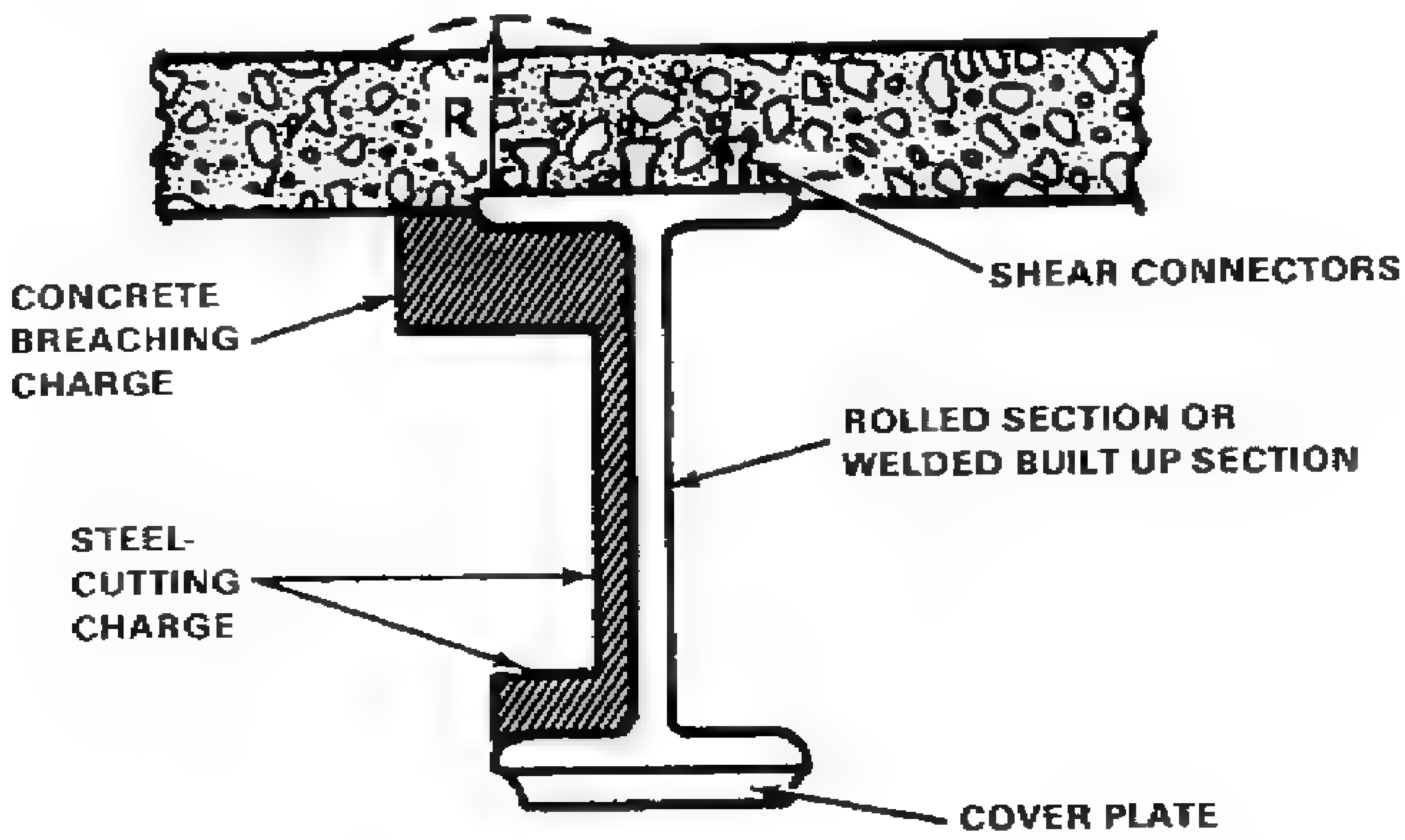


Figure 4-10. Charge placement on composite-steel concrete stringer

Steel-Girder Superstructures

Characteristics. Steel girders are generally used for spans of 100 feet to 350 feet. The girder is used in spans too long for standard rolled shapes. The girder bridge referred to in this discussion consists of two large built-up flexed members that support the roadway, as opposed to the stringer bridge that can have many equally spaced smaller girders or stringers. Girder bridges are usually of continuous construction, and frequently the girder is haunched (deepened) over the intermediate supports.

Method of demolition. Cut steel-girder superstructures by placing steel-cutting charges to cut each girder.

Reinforced-Concrete-Slab Superstructures

Characteristics. The concrete-slab superstructure is an efficient structure for short spans up to 25 feet. Multispan slab bridges are continuous over intermediate supports. Span lengths for continuous slab bridges rarely exceed 40 feet.

Method of demolition. Demolish reinforced-concrete slab superstructures by placing breaching charges across the width of the slab to breach it.

Reinforced-Concrete T-Beam Superstructures

Characteristics. Reinforced-concrete T-beam superstructures are used in simply supported spans of 30 to 60 feet and in continuous spans up to 100 feet. Continuous-span bridges normally use variable depth T-beams to provide a greater depth over the intermediate supports.

Method of demolition. As shown in Figure 4-11, demolish reinforced concrete T-beam superstructures by placing charges to cut each beam using one of the following methods:

- Place concrete breaching charges against the side of each beam.
- Place concrete breaching charges against the bottom of each beam.
- Place breaching charges on the deck above each beam.

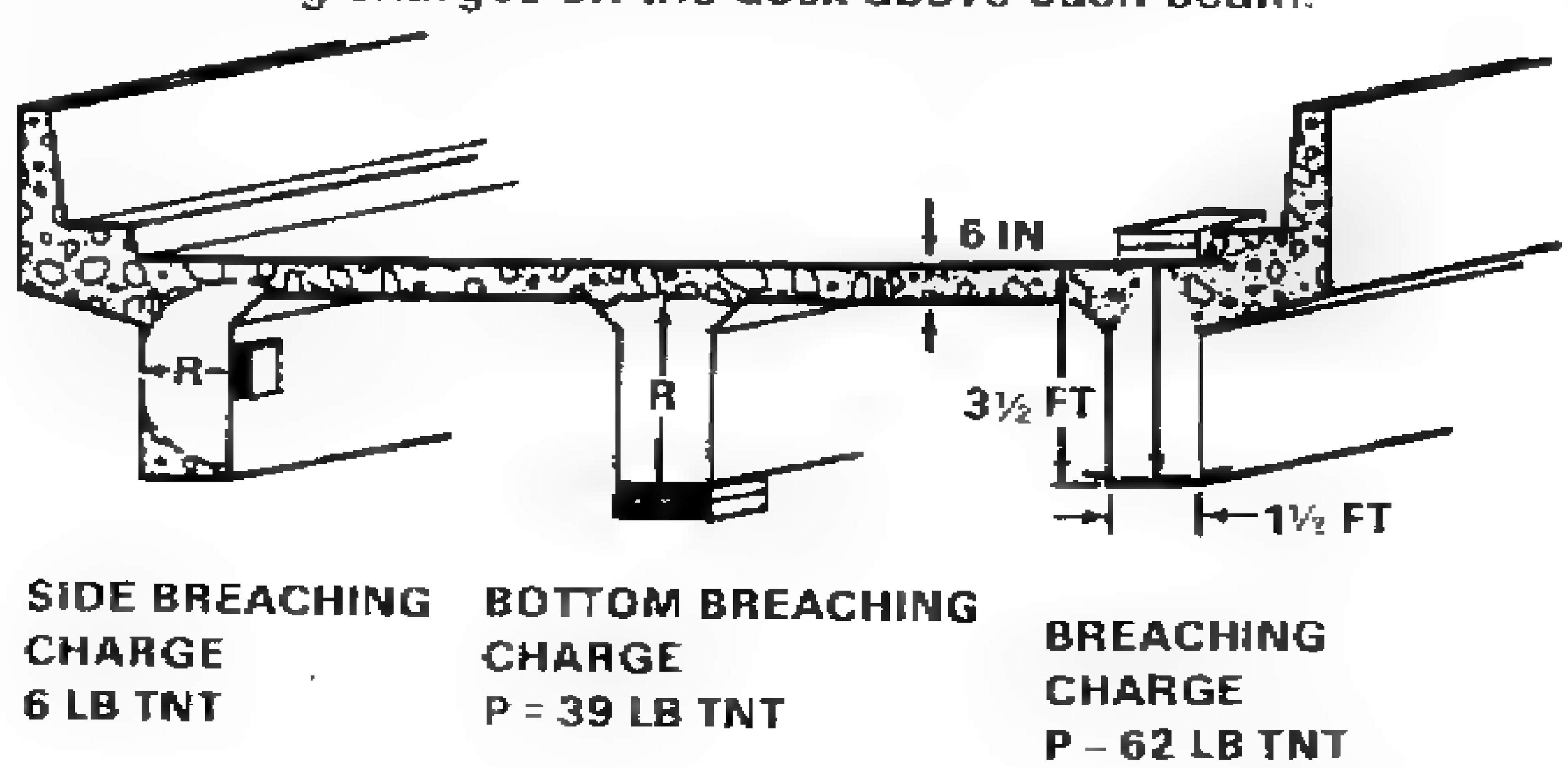
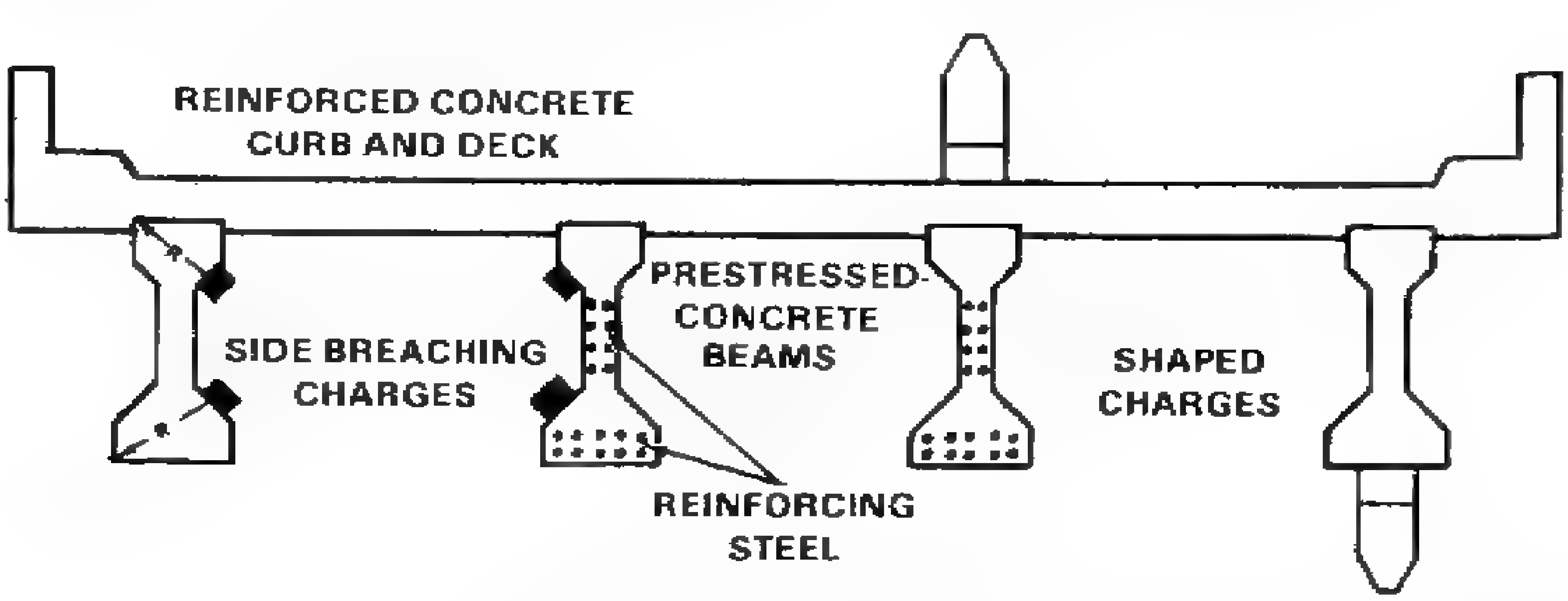


Figure 4-11. Demolition of reinforced-concrete T-beam superstructures

Prestressed-Concrete-Beam Superstructures

Characteristics. Prestressed-concrete-beam superstructures are basically concrete-stringer superstructures using high-strength steel and concrete. They are similar to reinforced-concrete T-beam superstructures but can be recognized by the I-shaped concrete beam (Figure 4-12). The spans may be supported or continuous. Spans up to 200 feet in length are currently being used.



NOTE: Pressure charges placed on top of prestressed-concrete beams are not effective.

Figure 4-12. Demolition of prestressed-concrete beam superstructures

Method of demolition. As shown in Figure 4-12, demolish prestressed-concrete-beam superstructures by using one of the following methods:

- Place dual concrete-breaching charges on one side of the beam and against the sloped sides of the top and bottom flanges of each beam. Butt the charges against the junction of the web and flanges to destroy the beam.
- Place M2A4 or M3A1 shaped charges over the top or against the bottom of each beam to cut the beam.

Concrete Box Beam Superstructure

Characteristics. Hollow, concrete box beam superstructures are of two types—the precast box beam and the large, monolithic hollow-box girder.

The precast box beams are individual beams 3 feet wide, laid adjoining each other and held together by transverse diaphragm rods. Grout the joints between adjoining beams. The grouts are used extensively in foreign countries for simple spans 40 to 60 feet long.

The large, cast-in-place hollow-box girder is generally used in continuous spans 60 to 160 feet long. These superstructures may have an access door to allow entry into the beams.

Method of demolishing precast concrete box beam superstructures. Cut precast concrete box beam superstructures by placing concrete breaching charges (calculated for reinforced concrete) against the bottom of each beam, and center the charge over the sides of the beam to cut the bottom and sides. Place charges at least one breaching radius away from the internal concrete diaphragms (determined by the location of transverse steel rods).

Method of demolishing hollow, concrete box girder superstructures. As shown in Figure 4-13, demolish hollow, concrete box girder superstructures by placing breaching charges to cut the bottom and/or sides of each box girder using one of two methods.

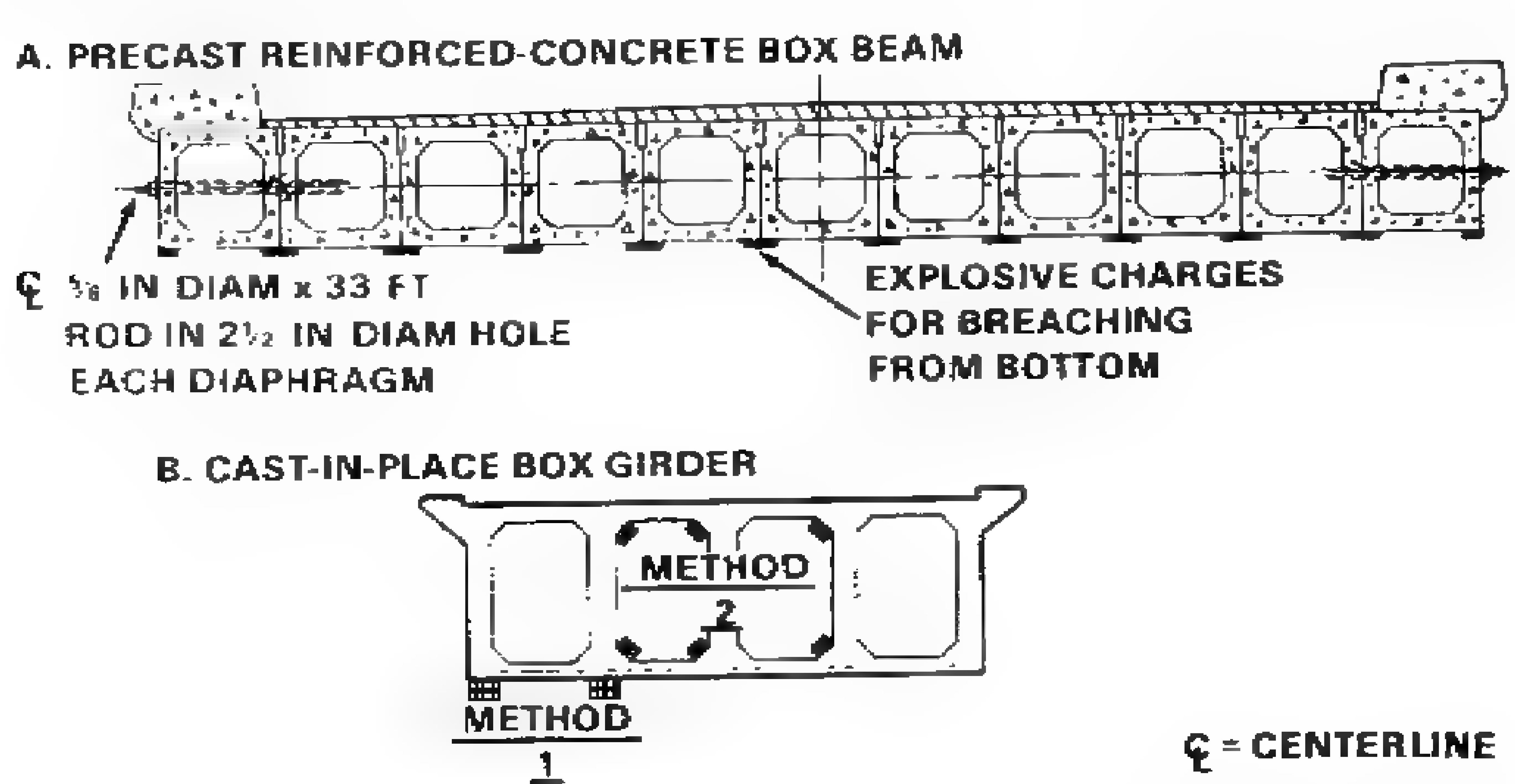


Figure 4-13. Demolition of concrete box beam superstructures

With the first method, place concrete breaching charges (calculated for reinforced concrete) against the bottom of each girder and center over the sides of the girders.

With the second method, place concrete breaching charges against the bottom and sides of each girder inside the hollow girder. Access to the inside of the beam must be available.

Truss Superstructures

Characteristics. Many different types of truss superstructures exist. Combinations of different types of trusses are often used in large bridges. Construction of a truss may be of any material including timber. However, steel or reinforced concrete is normally used. Their spans vary from 150 feet to over 1,000 feet. Some light truss superstructures are found in simple spans as short as 60 feet.

Method of demolition. Destroy truss superstructures by placing charges to cut the chords or the floor stringers depending on the degree of destruction desired (Figure 4-14). Use steel-cutting charges, concrete breaching charges, or timber-cutting charges, as appropriate. When partial destruction of a truss is acceptable, place the charges to cut only the tension chords, allowing the weight of the bridge to complete the destruction of the truss.

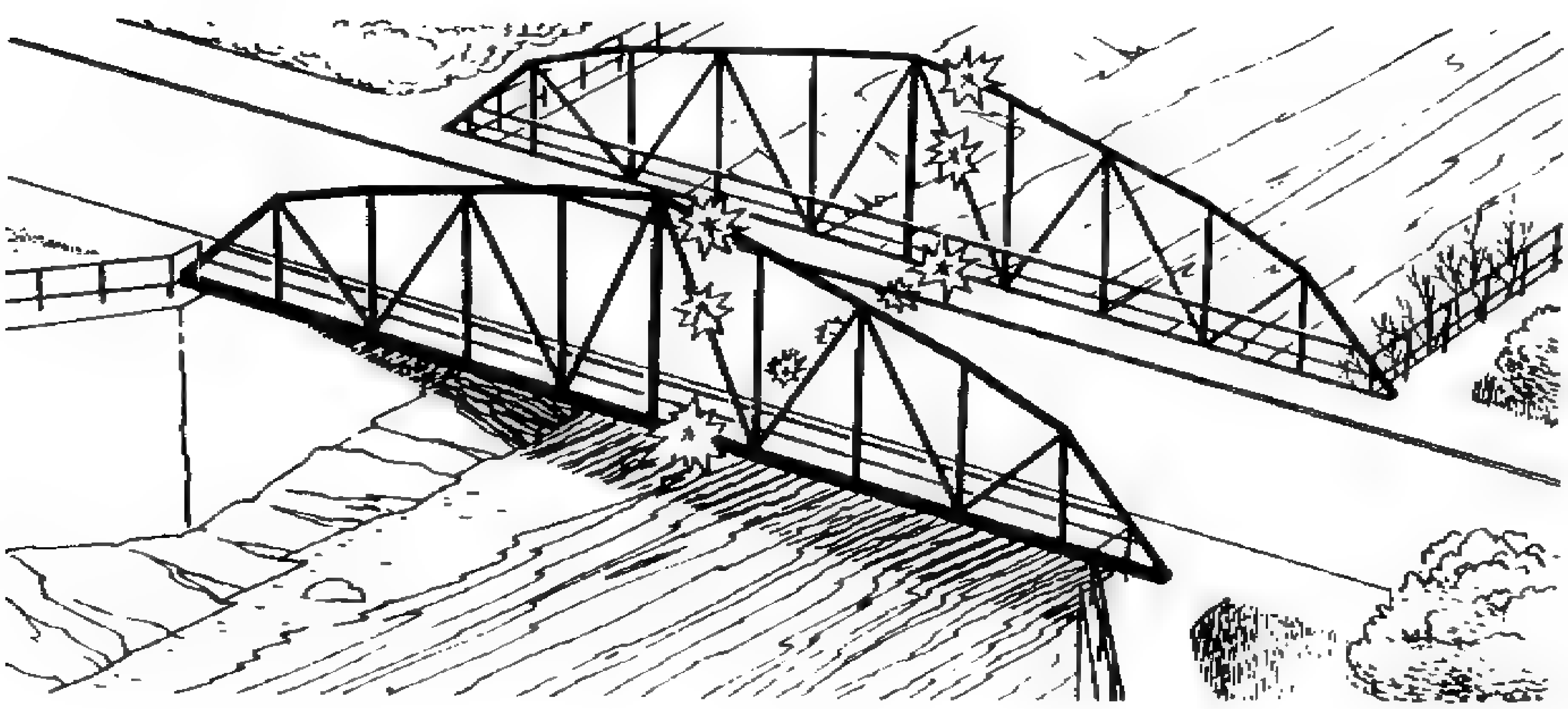


Figure 4-14. Demolition of a truss superstructure

Fixed Bridges

Fixed bridges have a great variety of substructures and superstructures. For demolition purposes, classify fixed bridges according to the way the superstructure is supported. Using this method, determine the placement of the charges to destroy the bridge and select the correct type of charge or charges based on the type of substructure and superstructure.

Simple-Span Fixed Bridges (Independent)

Characteristics. A simple-span fixed bridge is supported only at each end. It is perhaps the most common type of fixed bridge. It may be as simple as a single-span timber stringer bridge or as complex as a large truss bridge. Simple-span bridges can be recognized by the fact that each span is independent of the spans next to it. The stringers or girders of a simple-span bridge are of uniform depth and supported only at the ends (Figure 4-15). The trusses of a

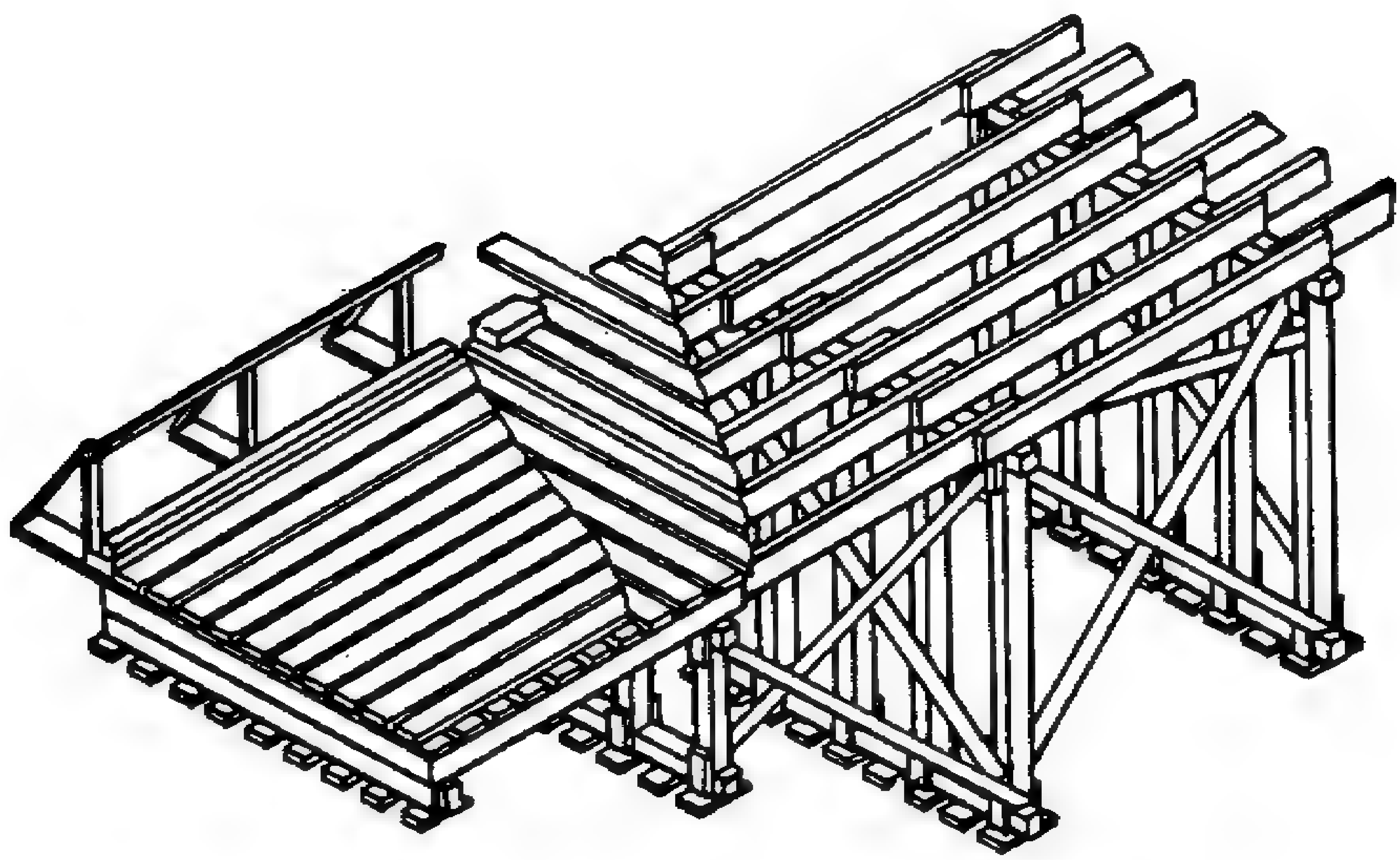


Figure 4-15. Simple-span, timber-stringer fixed bridge

simple-span bridge are of uniform height or higher (built up) in the center of the span, and the upper chords of adjacent trusses are not usually connected over a pier (Figure 4-16).

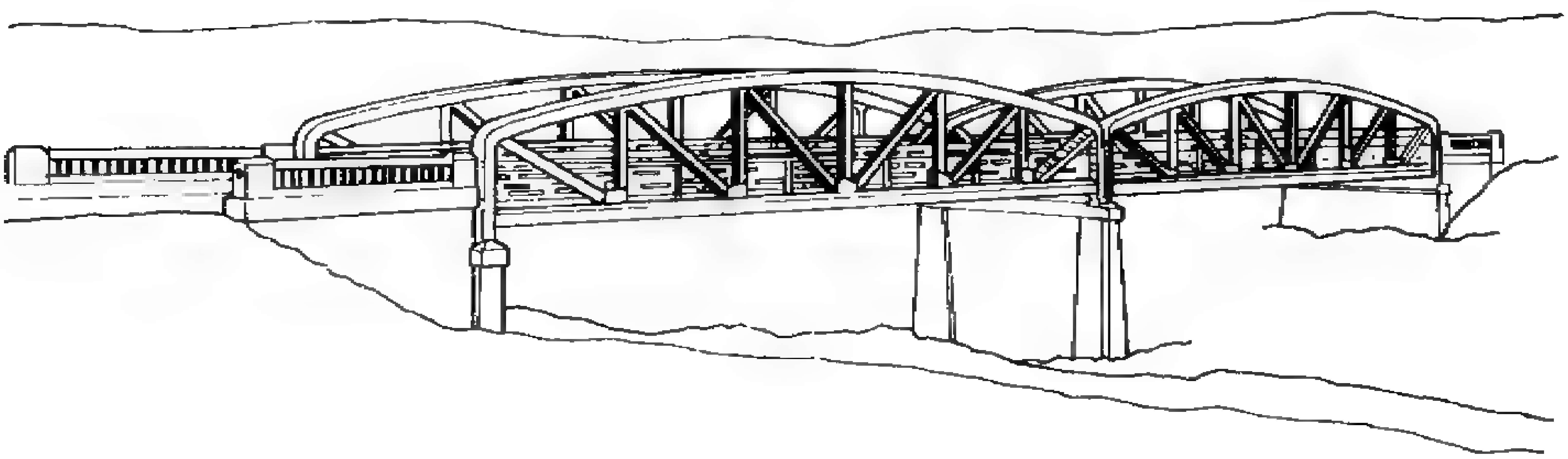


Figure 4-16. Simple-span truss bridge

Method of partial demolition. Partial destruction of a simple-span bridge is difficult because any demolition will destroy an entire span and may result in more than the desired damage to the abutments or piers by the dropping span. To destroy a girder or stringer bridge of this type, cut the span at an angle so that the span will fall without excessive damage to the abutments. To partially destroy a simple supported truss bridge, cut both trusses at one end, allowing one end of the bridge to fall into the river (Figure 4-17). If the distance to the river is not too great, the bridge span should come to rest on an incline with its uncut

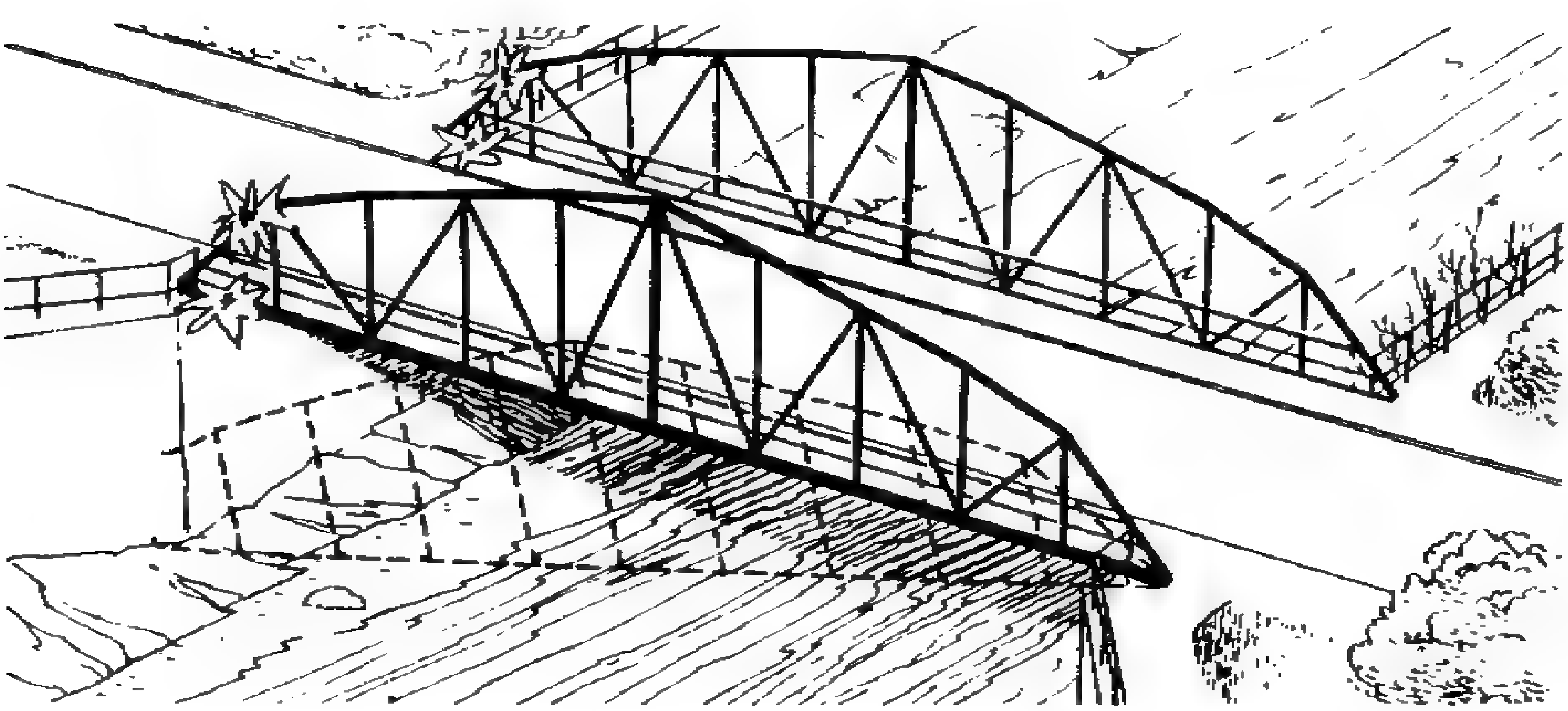


Figure 4-17. Partial destruction of a simple-span truss bridge

end on its abutment. This will deny the use of both the bridge and the river under it. The possibility remains that the greatest portion of the bridge is still intact and can be raised at some future time at considerably less expense than building a new bridge.

Method of complete demolition. There are several ways to completely destroy a simple-span bridge. One is to cut the bridge at midspan, allowing it to buckle and fall into the river below (Figure 4-14 on page 4 56). When the bridge falls, it will probably also damage the abutments.

An alternate way is to cut both ends of the truss or girder on the upstream side of the bridge close to the abutment, allowing the bridge to fall into the water (Figure 4-18). This method is more effective if the bridge rests relatively close to the surface of a swift-flowing stream. The water current will flow against the floor of the bridge which may complete the destruction by twisting the remaining truss or girder from the abutments and pound the bridge to pieces.

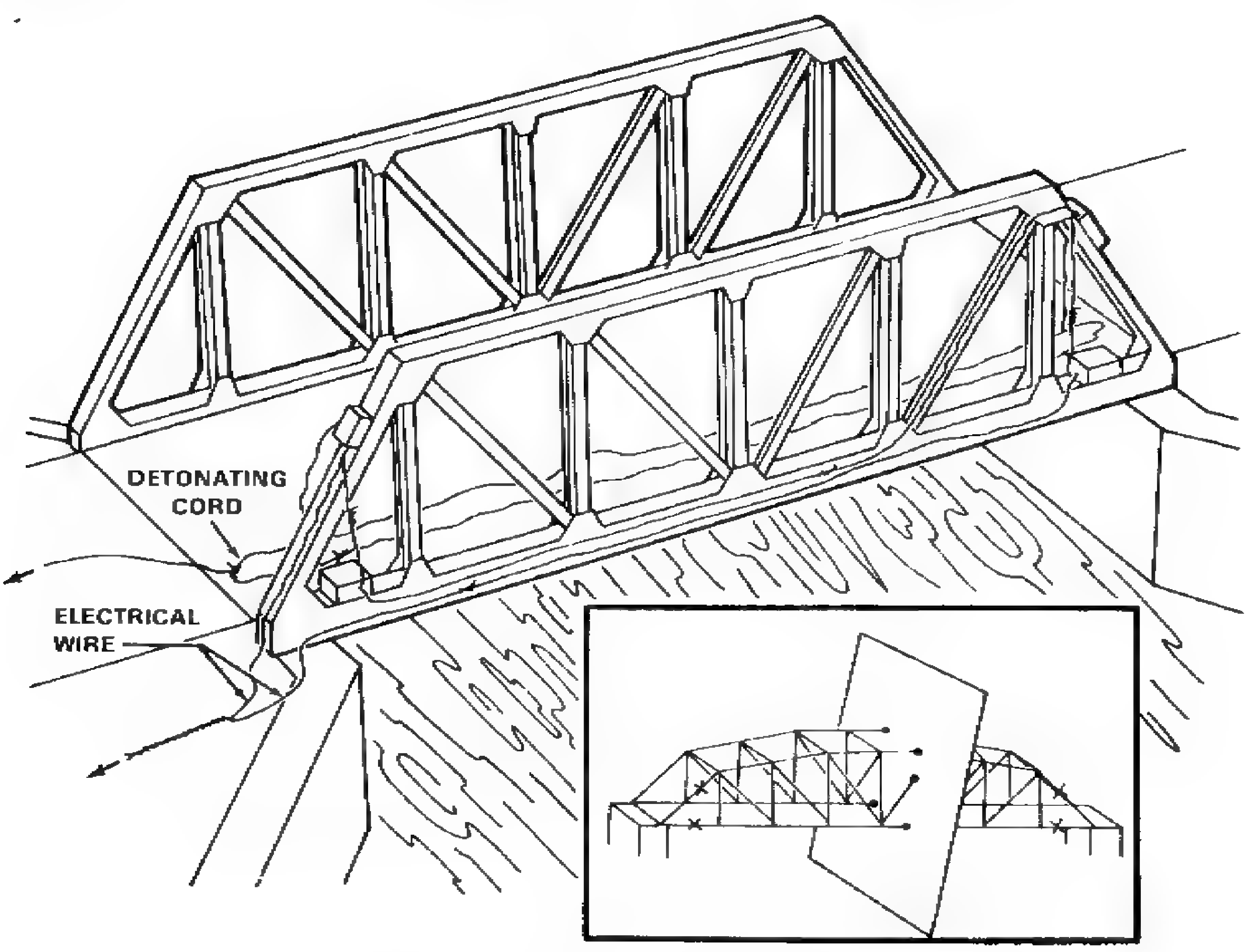


Figure 4-18. Complete destruction of a simple-span truss bridge

A third approach is to destroy each alternate pier of a multispan simple-span bridge by cutting each pier on a diagonal breach line. Alternate the direction of the cut on each pier, and cut the lower members of the span in the center at the same time. This will twist each span so that it may fall on its side between the piers, destroying them and leaving so much debris that extensive effort is required before a new bridge can be built

Continuous-Span Fixed Bridges

Characteristics. Continuous spans are supported at more than two points. The basic type of continuous-span bridge is a simply supported bridge with one pier under the center. Continous-span bridges can be recognized by the fact that the superstructure of the bridge is continuous over the intermediate support. Stringers and girders of a continuous-span bridge are normally deepened or haunched at the intermediate support (Figure 4-19) The trusses of a continuous-span bridge are highest over the supports and are connected at both top and bottom chords.

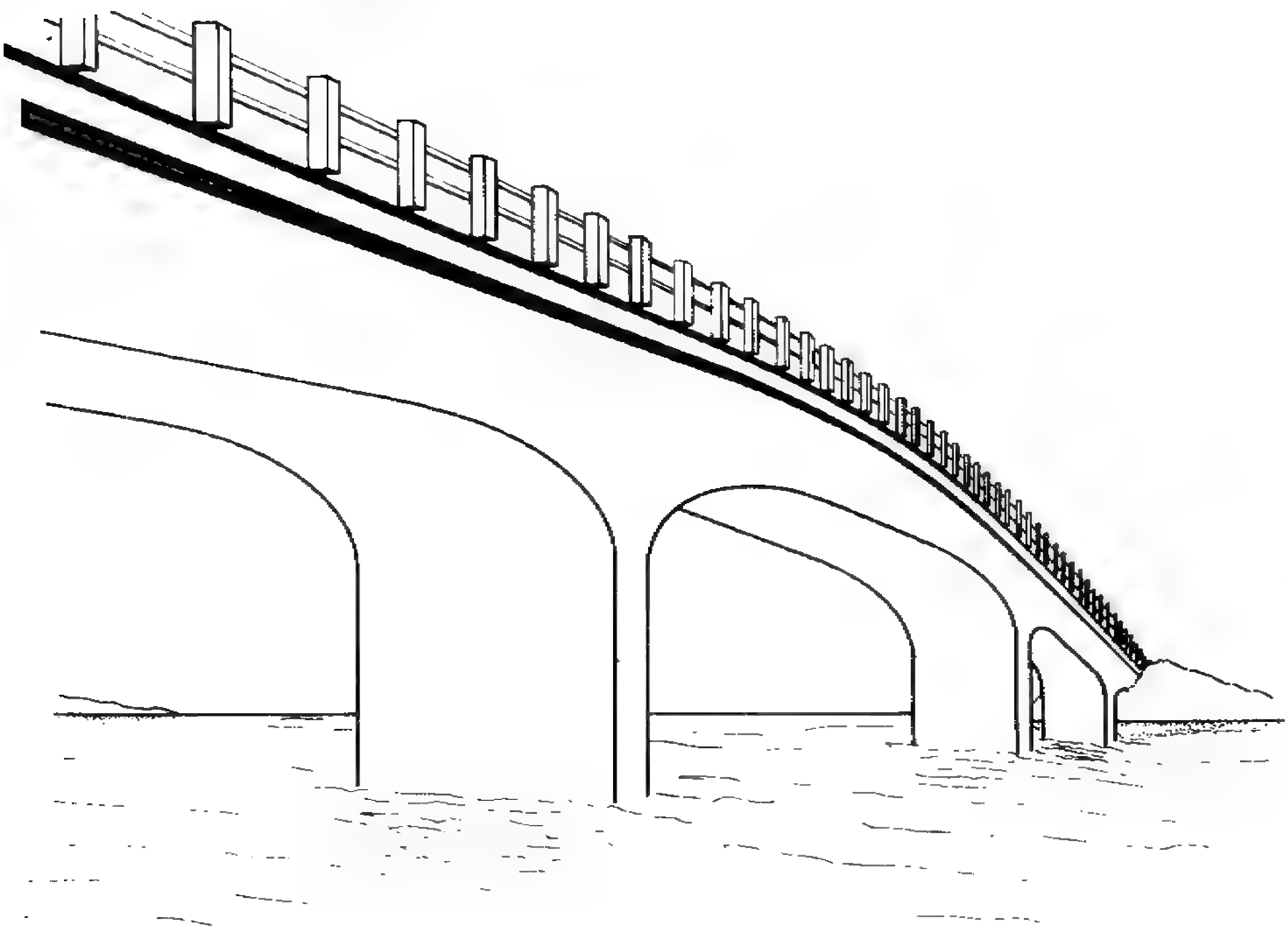


Figure 4-19. Typical continuous-span bridge

Method of partial demolition. Cut the span at the desired distance from one abutment for partial demolition of a continuous-span bridge (Figure 4-20). This will allow the desired portion of the bridge to drop into the stream, but because of the strength of the continuous span as it passes over the intermediate pier, the greatest portion of the bridge may remain in place for future use.

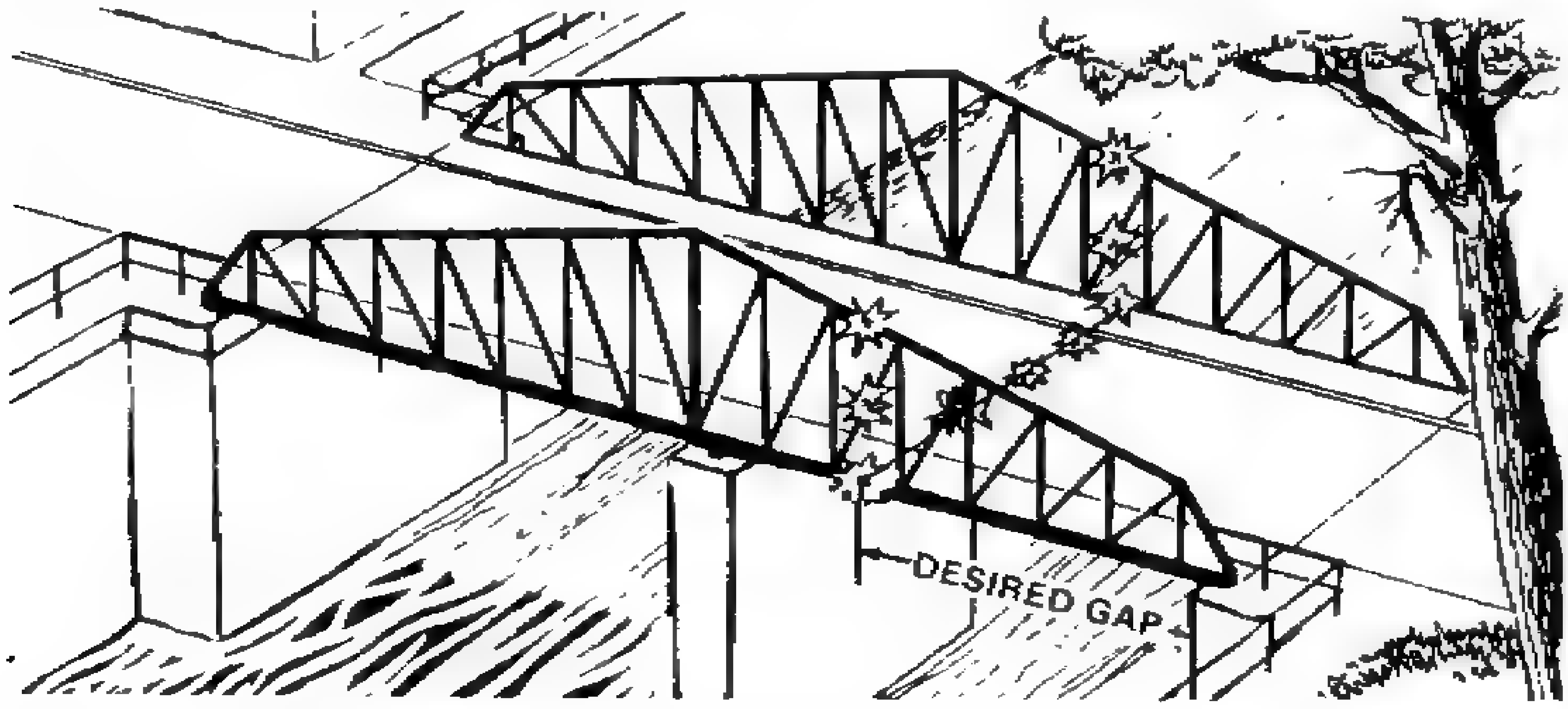


Figure 4-20. Partial destruction of continuous span

Method of complete demolition. Cut the span on each side of the intermediate piers for complete demolition of a continuous-span bridge. The cut should be at unequal distances from the piers so that the portion of the bridge over the pier will be unbalanced and fall. Under ideal conditions, the central portion will overturn or severely damage the supporting pier as it falls (Figure 4-21). The rule of thumb is to cut the span at three-fourths the total span length from the pier. If time and explosives are available, use breaching charges for demolition of the piers.

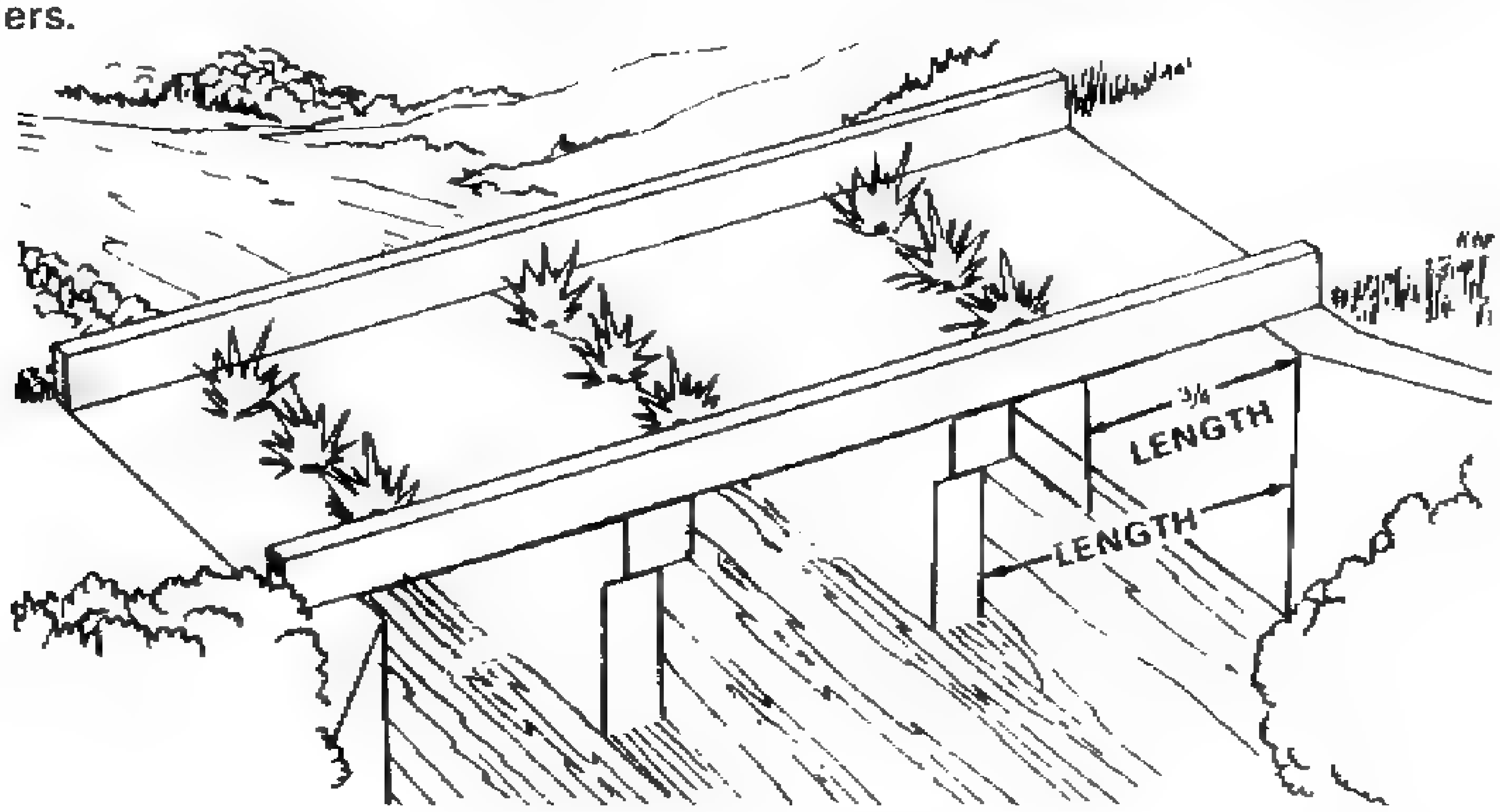


Figure 4-21. Complete destruction of continuous-span concrete-slab bridge

Cantilever Fixed Bridges

Characteristics. A cantilever span is a span with one end unsupported. A cantilever bridge has two arms that extend from opposite banks. Each arm is supported by a pier located approximately one quarter of the distance across the gap (Figure 4-22). The portion of the arm between the shore abutment and the pier is the anchor arm. The portion of the arm over the stream is the cantilever arm. The anchor arm may be anchored by a counterweight or solidly fastened to the abutment. Cantilever-span bridges may also have a separate span suspended between the ends of the cantilever arms.

Recognition factor. Cantilever bridges are difficult to distinguish from continuous-span bridges because the structural members of a cantilever bridge are also deeper across the intermediate supports. Careful examination of the individual members of the bridge is necessary. The major difference between continuous- and cantilever-span bridges is the method in which individual members are stressed. The upper members of a cantilever bridge are tension members. In all other types of spans, the lower members are tension members. Close examination of the abutment support may also indicate a cantilever bridge. The existence of a suspended span also identifies a cantilever bridge.

Method of partial demolition. Cut the hangers of a cantilever bridge so the suspended span will drop for partial demolition (Figure 4-22). If there is no suspended span, cut a portion of the cantilever arm as shown in Figure 4-23.

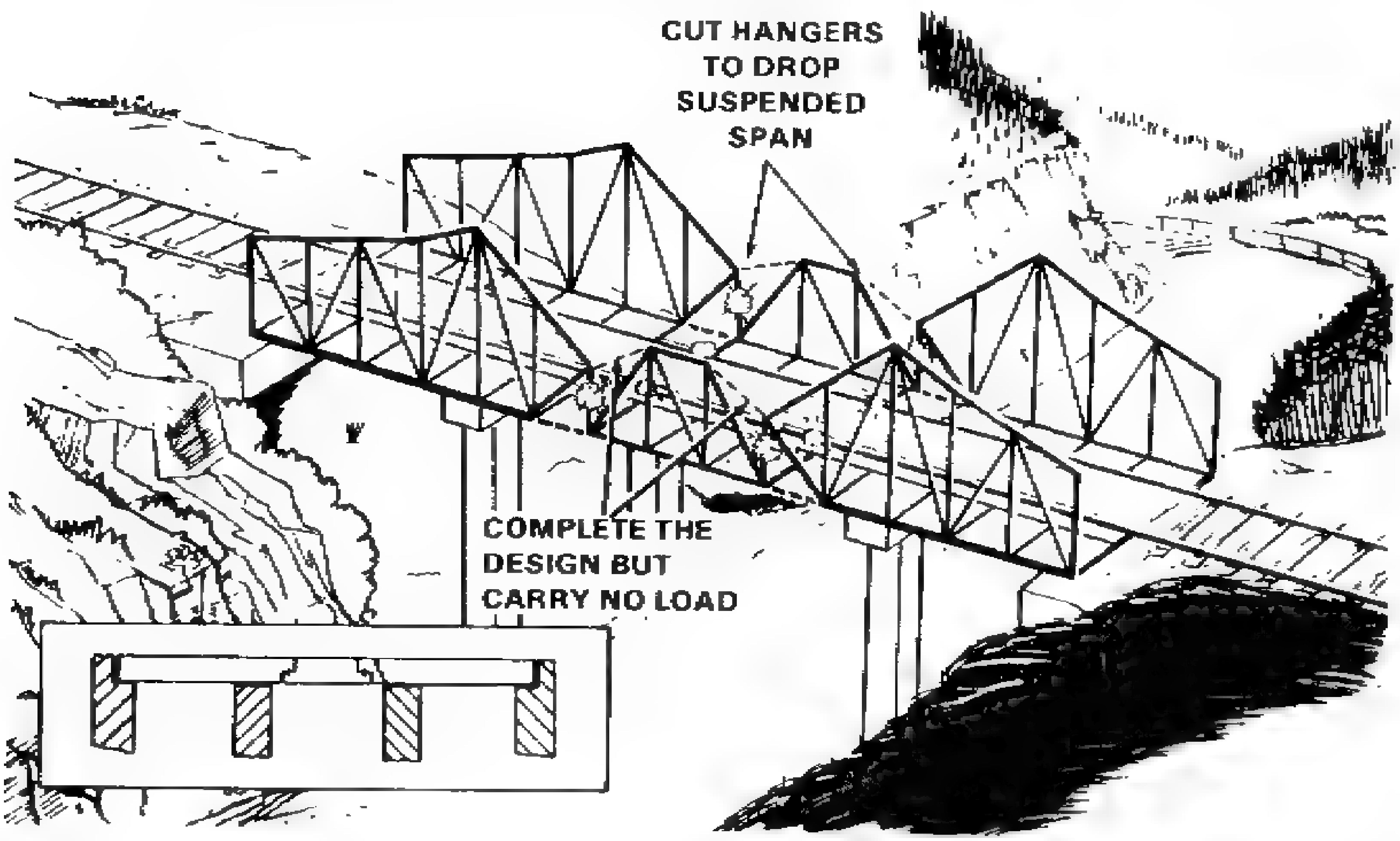


Figure 4-22. Partial destruction of cantilever truss with suspended span

Make every effort to have all charges detonate simultaneously in either case. If one end of the span were to fall before the other, the cantilever arm might be damaged to a greater extent than necessary or desired.

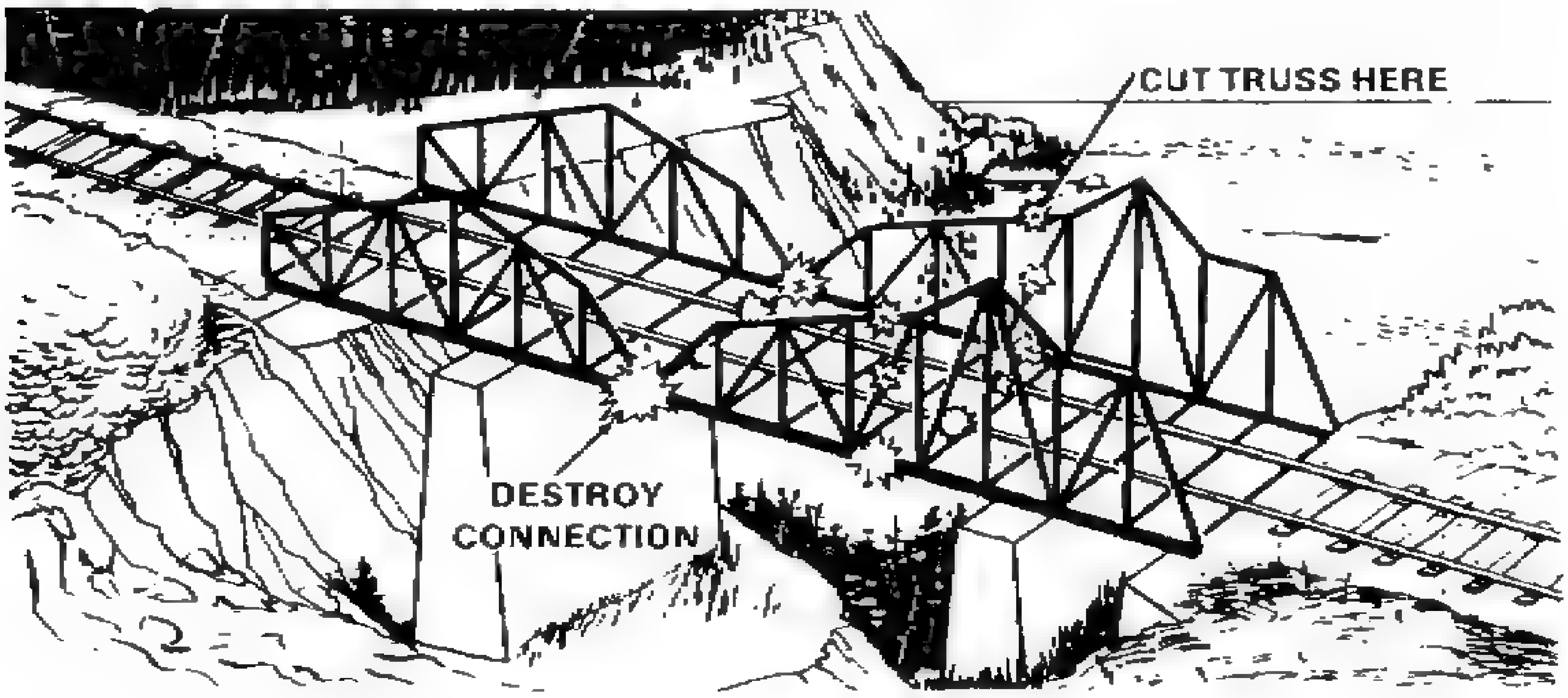


Figure 4-23. Partial destruction of cantilever truss without suspended span

Method of complete demolition. Cut the cantilever arms at unequal distances from the supporting pier for complete demolition of a cantilever bridge. This method will cause overturning of the portion of the bridge supported by the pier (Figure 4-24)

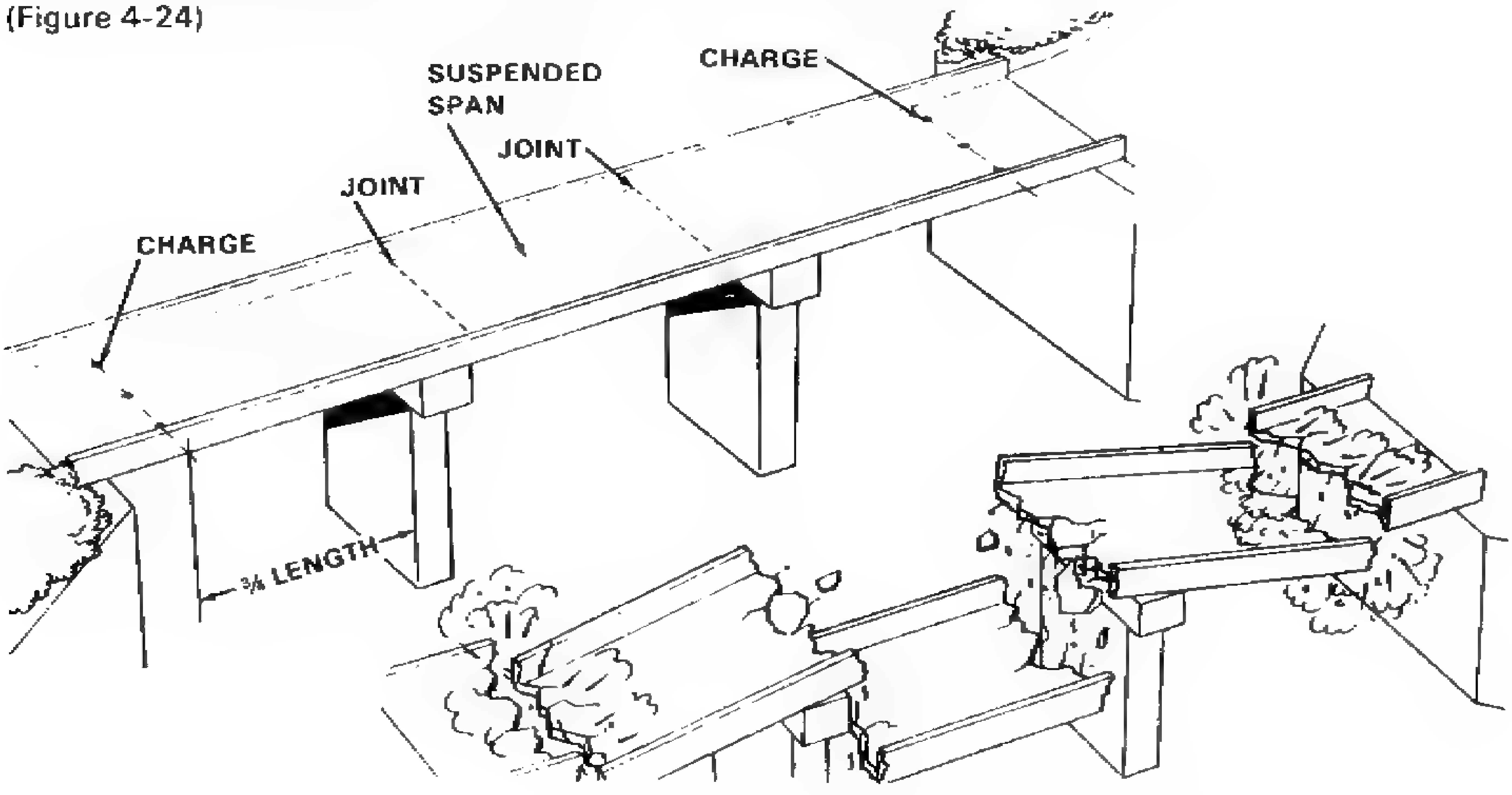


Figure 4-24. Complete destruction of concrete-slab cantilever bridge with suspended span

Arch-Span Fixed Bridges

Components. The components of bridge arches are described here and illustrated in Figure 4-25. Bridge arch component descriptions follow.

- A span is the horizontal distance from one support of an arch to the other measured at the spring line.
- Spring lines are the points of junction between the arch and the supports.
- A rise is the vertical distance measured from a horizontal line connecting the supports at the base of the arch to the highest point on the arch.
- The crown is the highest point on the arch
- Abutments are the supports of the arch.
- Haunches are those portions of the arch that lie between the crown and the spring lines.
- Spandrels are the triangular-shaped areas between the crown and abutment and above the haunches.

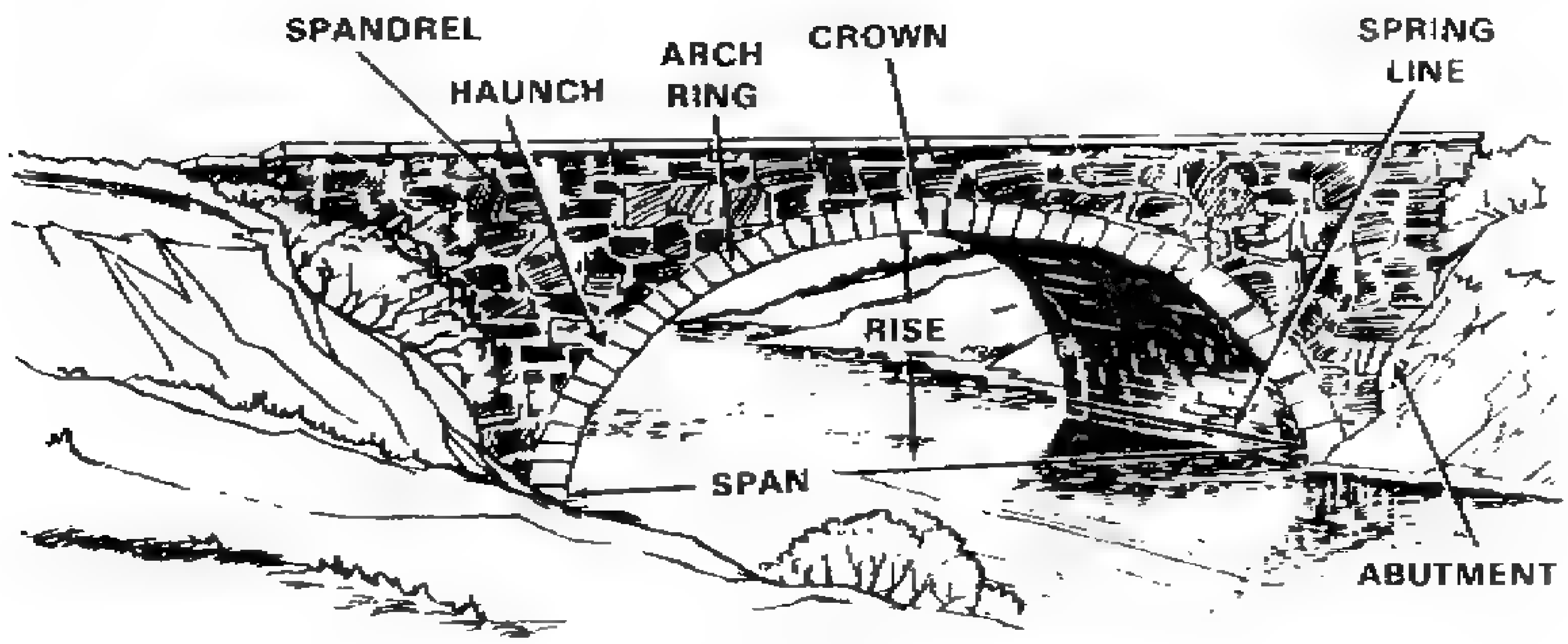


Figure 4-25. Arch components

Filled-spandrel arch. A filled-spandrel arch consists of a barrel arch, a comparatively short span, supporting an earth or rubble fill between the retaining walls. The arch is most vulnerable at its crown where it is thinnest and the earth fill is usually only a foot or two thick. Filled-spandrel arches are constructed of masonry (stone or brick), reinforced concrete, or a combination of these materials. Destroy these arches by placing breaching charges at either the crown or haunch.

Method of demolition using crown charges. Crown charges are easier to place than haunch charges, but their effectiveness is substantially less, particularly on an arch with a rise that is large in comparison with the span. Crown charges are more effective on flatter arches because the flatter shape permits a longer portion of the arch to drop out of the bridge. Place breaching charges as shown in Figure 4-26.

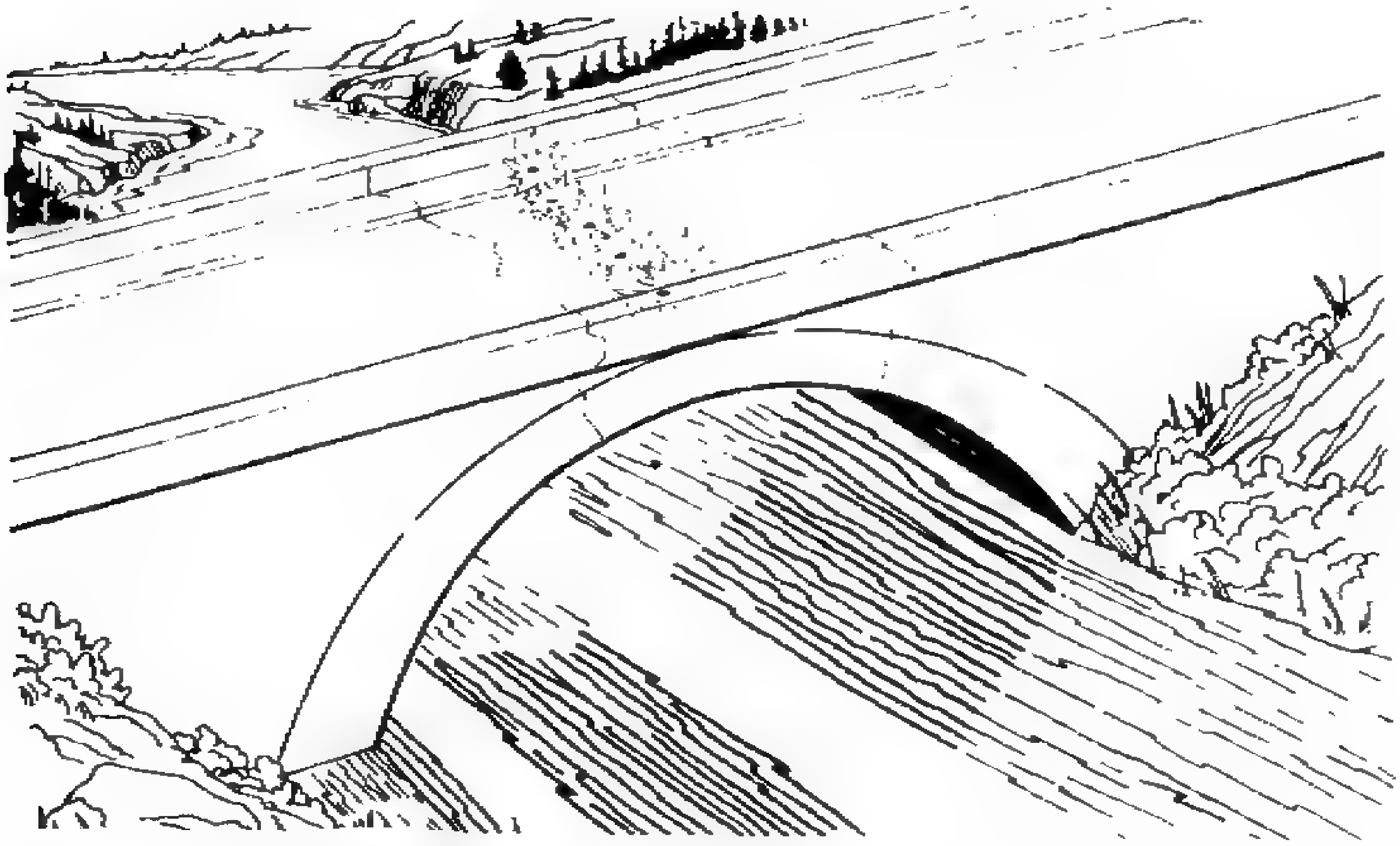


Figure 4-26. Breaching by crown charges on filled-spandrel arch bridge

Method of demolition using haunch charges. Place breaching charges at the haunches, which are just ahead of the abutment, as shown in Figure 4-27. Traffic can be maintained until they are fired. If the bridges have demolition vaults or chambers built into the haunches, place the charges there. The presence of demolition vaults is revealed by the ventilating brick or steel plate laid in the side wall of the arch. Place the charges in the haunch on the left side, and the explosive will drop out that portion of the arch between lines C and D as shown in Figure 4-27. Place the charges in both haunches, and the explosion will cut that portion of the arch between lines C and E. Place breaching charges on the arch ring, either in holes on the top or supported on the underside.

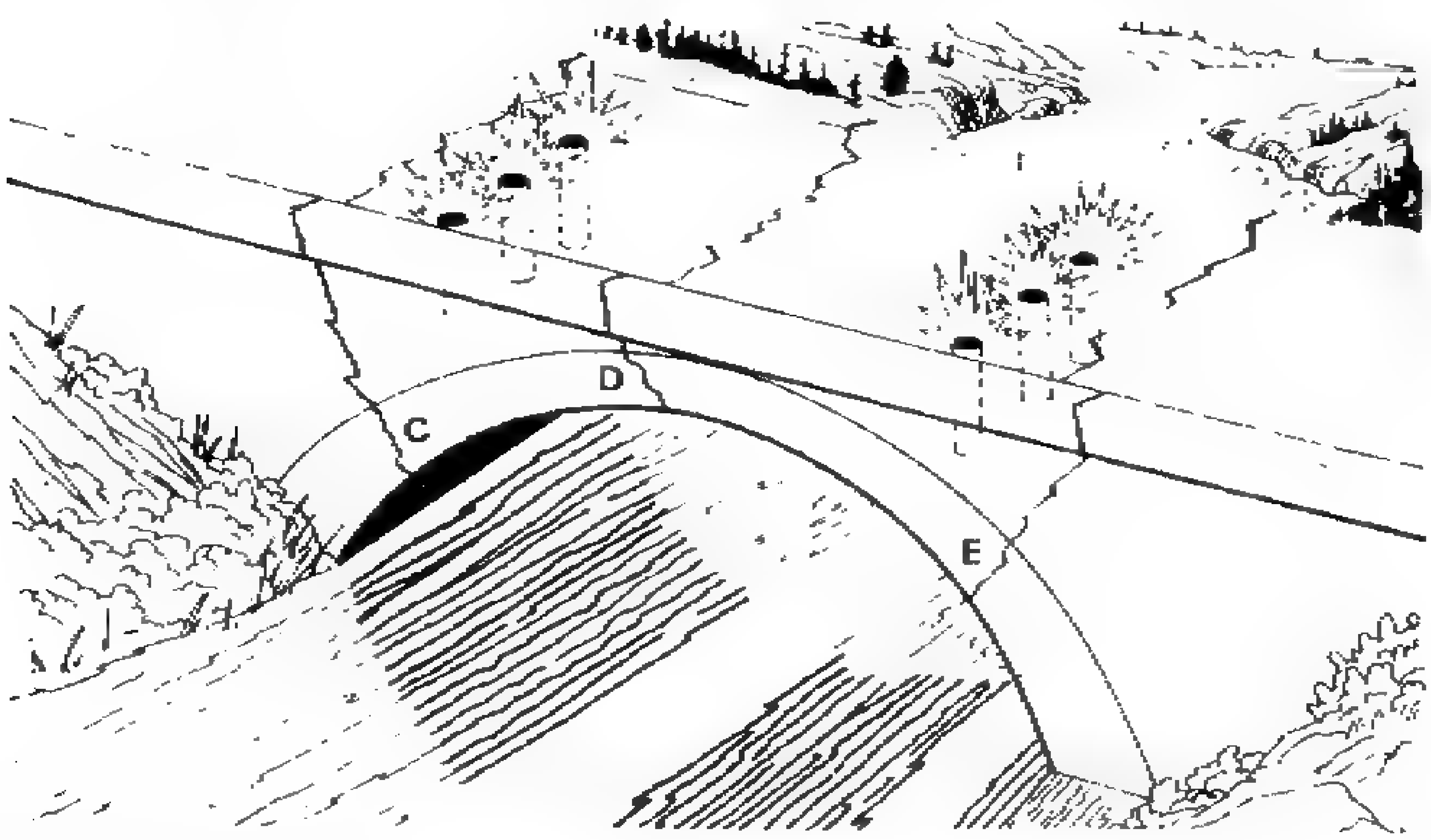


Figure 4-27. Breaching by haunch charges on filled-spandrel arch bridge

Open-Spandrel Arch Bridges

An open-spandrel arch consists of a pair of arch ribs that support columns or bents, which in turn support the roadway. The number of arch ribs may vary, and, on rare occasions, the spandrel bents may be placed on a full-barrel arch similar to that which supports the filler material of the filled-spandrel arch. The open-spandrel arch bridge may be constructed of reinforced concrete, steel, timber, or any combination of those materials.

Characteristics. The ribs of a concrete-open-spandrel arch bridge are about 5 feet wide (Figure 4-28). The thickness of the arch rib at the crown varies from approximately 1 foot for spans 50 to 60 feet long to 3 feet for spans of 200 feet or more. The arch thickness at the spring line is ordinarily about twice the thickness at the crown. In long spans, the ribs may be hollow. The floor slab is close to the crown, permitting packing of charges against the rib at this point.

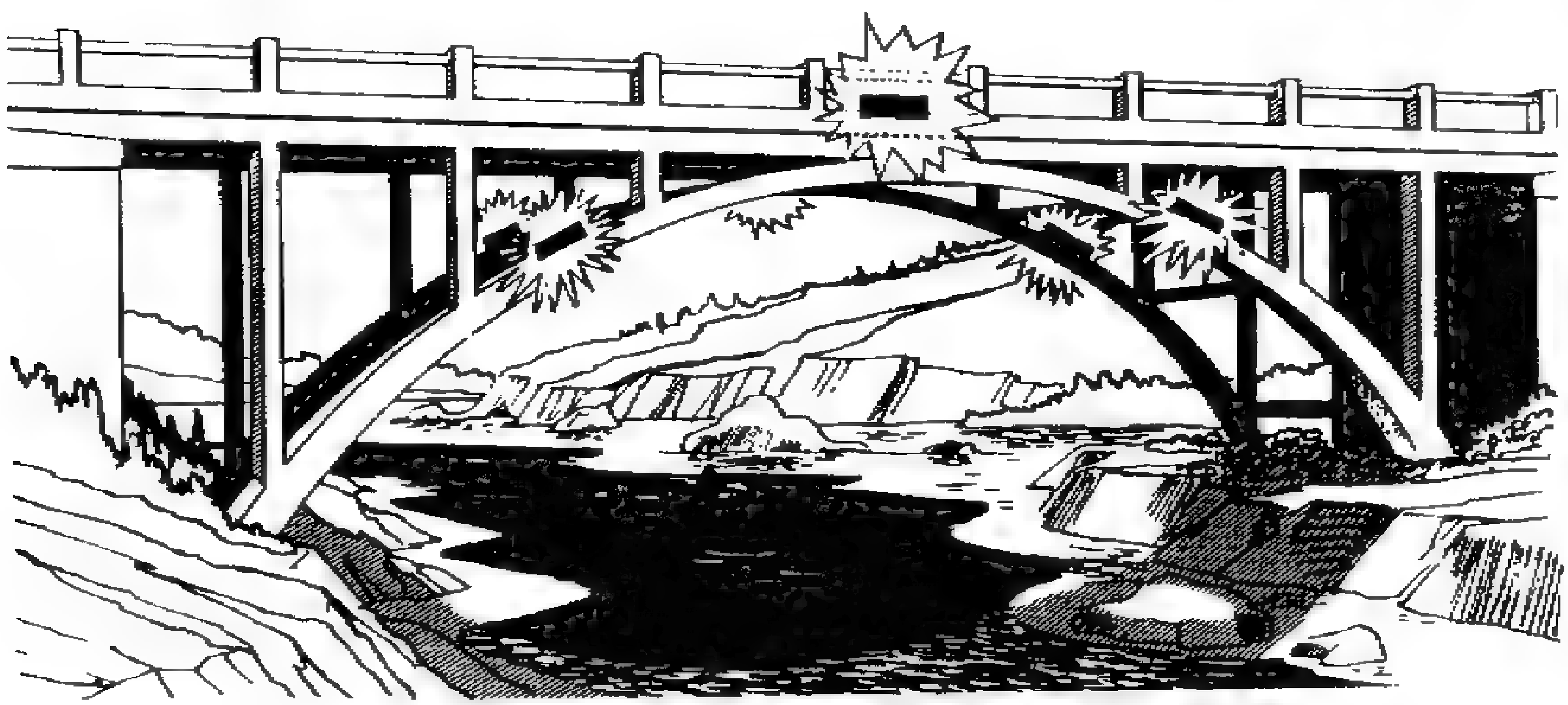


Figure 4-28. Demolition of reinforced-concrete open-spandrel arch bridge

Method of demolishing a concrete-open-spandrel arch. For structural reasons, the haunch over the abutment is most likely to be heavy. Effective destruction of the arch itself by means of light crown charges may leave a substantial pier at the roadway level in an undamaged condition. This type of structure is built in one massive unit rather than in lighter separate component parts and is very tough. Also, cutting the span at each end may drop the whole span only a relatively short distance. This could make the damaged bridge an excellent support for building a new temporary bridge. To prevent use of such a span, place one charge on the haunch and another at the crown. The uncut half-span will fall if the total span exceeds 50 or 60 feet. Compute the charge at the haunch for placement at either the ring or the pillar over the support, which ever has the greater radius. For short single-arch spans, destroy the entire span with breaching charges laid behind the abutments or behind the haunches.

Method of demolishing a steel arch. Steel arches are of four general types—continuous arches, one-hinged arches, two-hinged arches, and three-hinged arches (Figure 4-29). One-hinged arches are hinged in the middle; two-hinged arches, at both ends; three-hinged arches, at both ends and in the middle. Destroy continuous arches and one-hinged arches by placing charges at both ends of the span just far enough from the abutment to allow the arch to fall. Destroy two-hinged and three-hinged arches by placing one charge apiece at the center of the span.

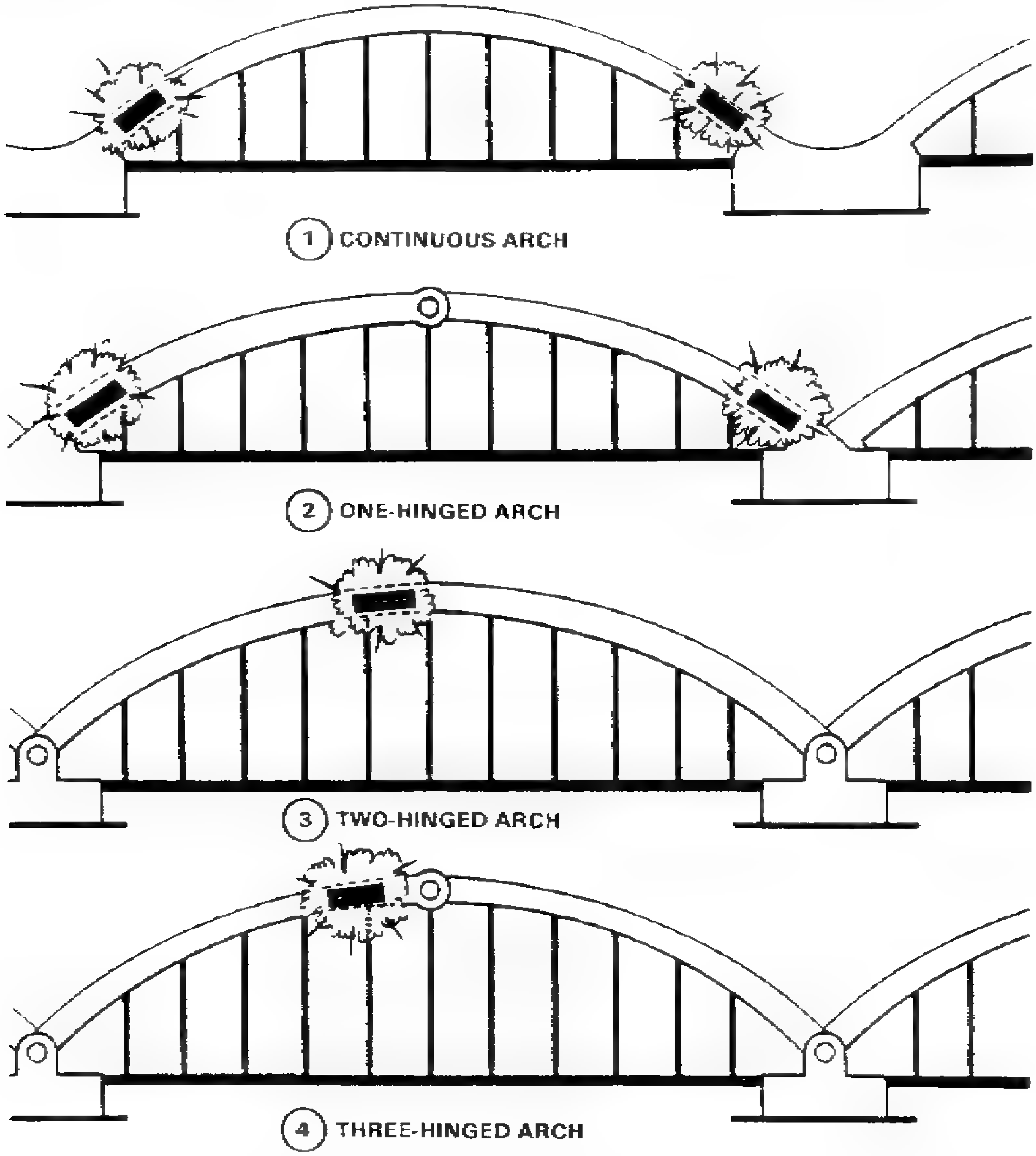


Figure 4-29. Demolition of steel arch bridges

Suspension-Span Bridges

The suspension span bridge is usually a major bridge distinguished by two characteristics—the roadway is carried by a flexible member (usually a wire cable) and the spans are long (Figure 4-30).

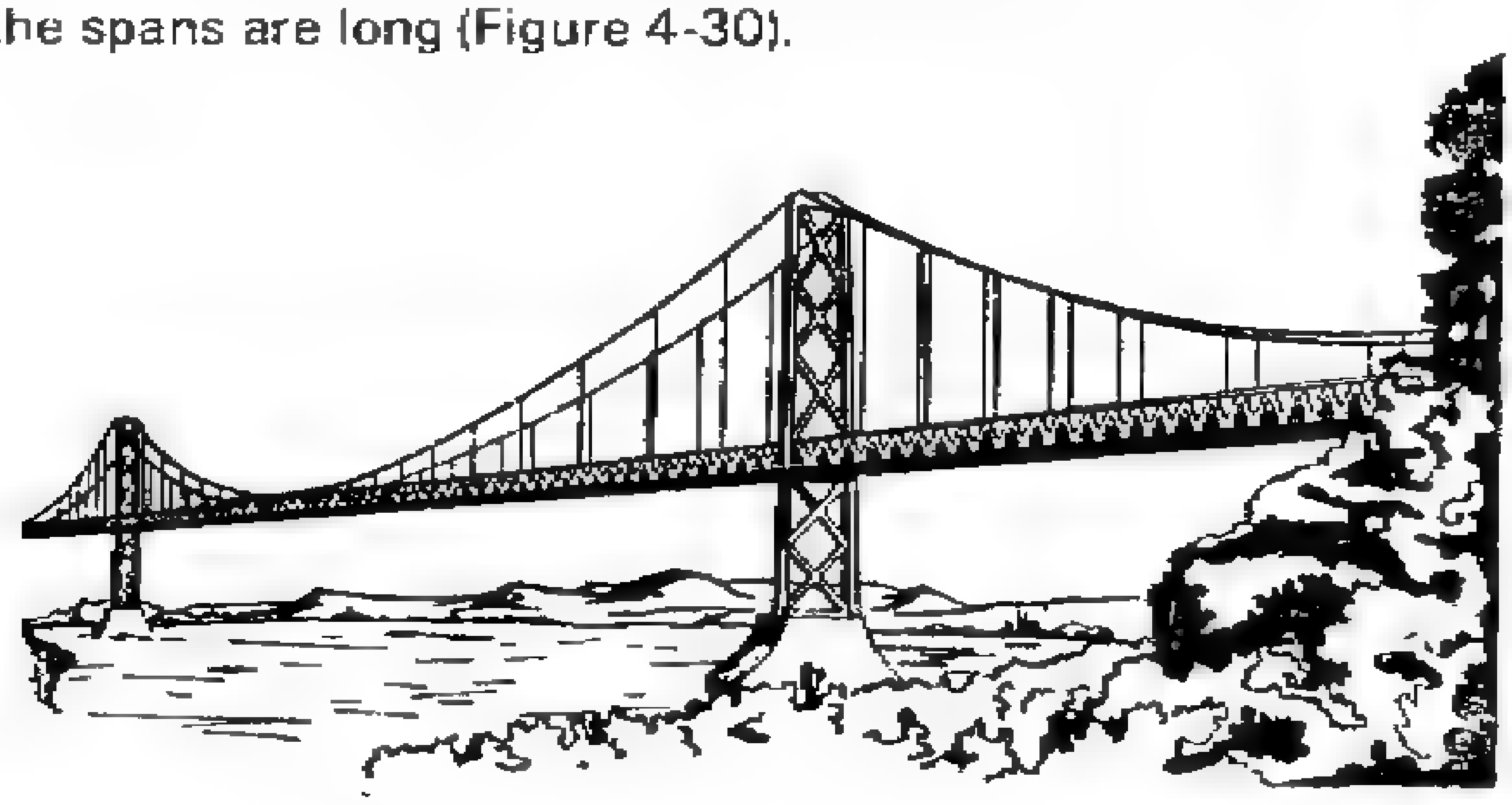


Figure 4-30. Suspension-span bridge

Components. The components of a suspended span bridge are cables, towers, trusses or girders, and anchorages.

The cables of suspension bridges are usually two steel multiwire members that pass over the tops of towers to anchorages on each bank. The cables are the load-carrying members. (The Golden Gate bridge has 127,000 miles of cable wire.) The towers of suspension bridges support the cables or load-carrying members. They may be made of steel, concrete, masonry, or a combination of these materials.

The trusses or girders of suspension bridges do not support the load directly. They provide stiffening only. The anchorages of suspension bridges are merely the settings of the splayed ends of the cables in rock or a concrete mass. They may be as large as 10,000 cubic feet.

Method of demolishing major suspension bridges. The anchorages of a major suspension bridge are usually too massive to be destroyed, and the cables are too thick for positive cutting with explosives. The most economical method of destruction is either dropping the span leading onto the bridge or dropping a section of the roadway by cutting the suspenders of the main or load-bearing cables. Determine the length of this section by analyzing what capabilities the enemy has for repair in the time the enemy is expected to retain the site, particularly for erection of a prefabricated bridge. It may also be feasible where there are reinforced-concrete towers to breach off the concrete and cut the steel.

Method of demolishing minor suspension bridges. The two vulnerable points of a minor suspension bridge are the towers and the cables. The methods of demolishing these points are described in the following paragraphs.

Destroy the towers by placing the charges on the towers slightly above the level of the roadway Cut out a section of each part of each tower. Place a charge on each post to force the ends of the cut out section to move in opposite directions and twist the tower. This will prevent the end of a single cut from remaining in contact. Demolition chambers, provided in some of the newer bridges, make blasting easier, quicker, and more effective.

Destroy the cables by placing the charges on the cables as close as possible to firm support, such as at the top of the tower or at an anchorage. Take extreme care **not** to extend the charges more than one-half the distance around the circumference of the cable The charges are bulky, exposed, and difficult to place, and the cables are difficult to cut because of the air space between the individual wires. Shaped charges, with their directed force effect, can be used to advantage.

Movable Bridges

A movable bridge is a bridge having one or more spans that can be positioned to open a clear passage or to give increased clear height for traffic in navigable channels. The three basic types of movable bridges are swing span, bascule, and vertical lift. The characteristics of these bridges are described in the next paragraphs

Swing-Span Bridges

Characteristics. A swing span is a continuous span that can be rotated on its central pier to provide clear passage for waterborne traffic. The arms of a swing-span bridge may or may not be of equal length. If the arms are of unequal length, weights are added to balance them. The weight of the span is carried by rollers which run on a circular track atop the center pier; the pivot serves as a center only. The swing span of a bridge is independent from any other spans of the bridge. The swing-span bridge can be recognized by the wide central pier under the swing span. This central pier is much wider than the one under a continuous span to accommodate the necessary rollers and turning mechanism that rotate the span (Figure 4-31).

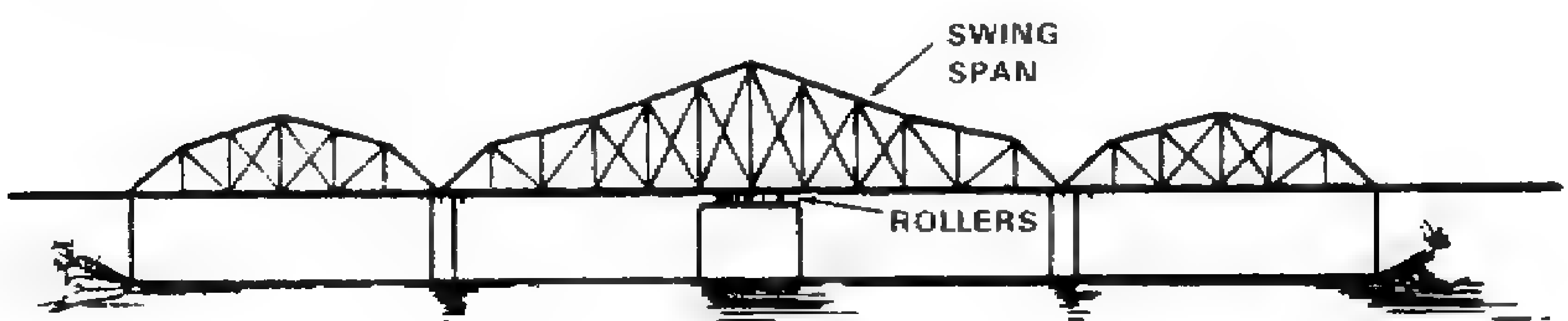


Figure 4-31 Swing-span truss bridge

Method of demolition. Because the swing-span bridge is a continuous type of bridge, partial and complete destruction can be accomplished as discussed in Chapter 4, Continuous-Span Fixed Bridges. The swing span can also be swung open, and the rotating mechanism damaged for partial demolition if necessary.

Bascule Bridges

Characteristics. The bascule bridge is more commonly referred to as a drawbridge. There are usually two leaves which fold upward when the bridge is open, as shown in Figure 4-32, but there may be only a single leaf, as shown in Figure 4-33. Bascule bridges appear in three general forms. The first two forms have movable arms balanced by a counterweight.

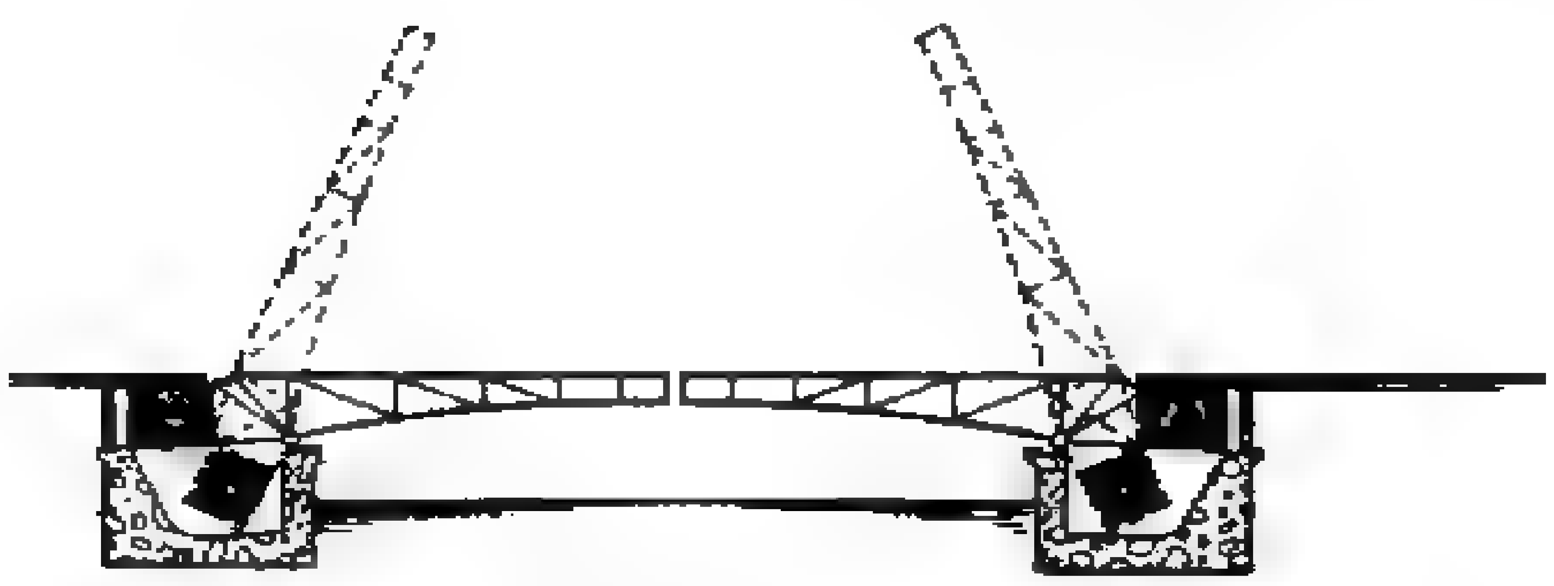


Figure 4-32. Double-leaf bascule bridge

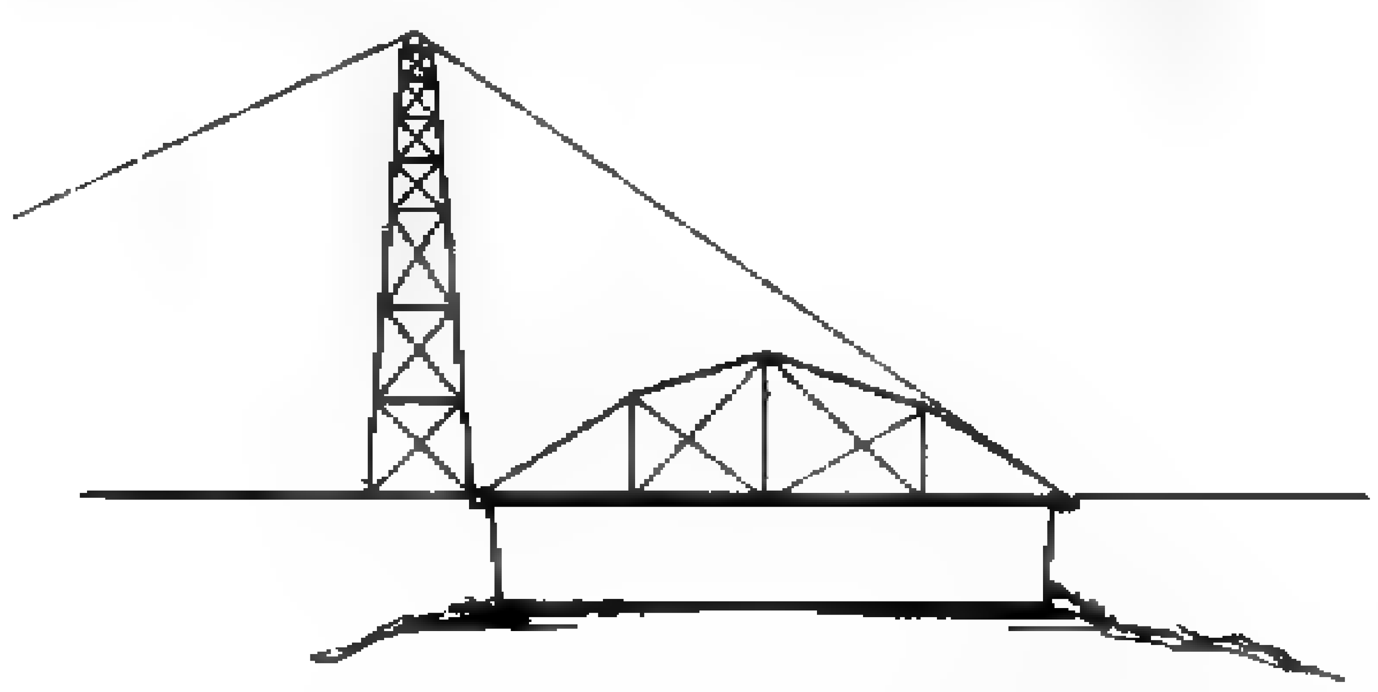


Figure 4-33. Single-leaf bascule bridge

The type illustrated in Figure 4-32 is the most modern design and is characterized by having the counterweight below the road level. The older type may have the counterweight above the road level. The third form, shown in Figure 4-33, has no counterweight but is lifted by a cable or rope. This is a very early form of bascule and is widely used in underdeveloped countries throughout the world. This type is normally made of timber to reduce the weight of the movable span.

Method of demolition. The cantilever arms of a bascule bridge can be demolished as discussed in Chapter 4, Cantilever Fixed Bridges, to effect either partial or complete destruction. In addition, the operating mechanism can be damaged to jam the bridge in the opened position.

Vertical Lift Bridges

Characteristics. The movable span is a simple span which can be raised vertically out of the path of traffic. The simple span is supported on cables that pass over rollers and are connected to large, movable counterweights. The height of the towers will govern the height to which the span can be raised (Figure 4-34).

Method of demolition. The movable span of the vertical lift bridge can be destroyed the same way as any simple span or the cables supporting the counterweights can be cut. Cutting these cables will prevent raising the bridge. Cut one end of the movable span free when the bridge is raised to accomplish complete or partial demolition. The movable span will either wedge between the supporting towers or fall free and severely damage the other tower.

Floating Bridges

Floating bridges consist of a continuous roadway of metal or wood supported by floats or pontons (Figure 4-35).

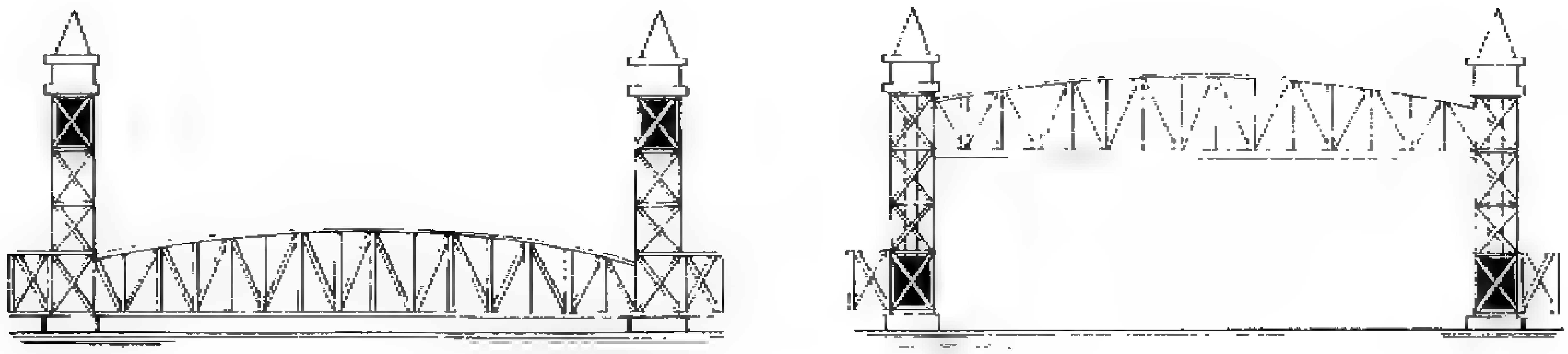


Figure 4-34. Vertical lift bridge

Pneumatic floats. Pneumatic floats consist of rubberized fabric made into airtight compartments and inflated with air.

Cut the anchor cables and bridle lines with axes, and cut the steel cables with explosives for a hasty method of demolition.

Puncture the floats by small arms or machine-gun fire for a deliberate method of demolition. This method requires a considerable volume of fire because of the large number of watertight compartments in each float. Make a clean cut through the material using detonating cord stretched snugly across the surface of the inflated ponton compartments. One strand is enough to cut most fabrics, but two strands may be needed for heavier material. Also, one turn of detonating cord around an inflation valve cuts it off at the neck or does other damage. Lines placed around valves should not be main lines but branch lines that are run off from the main line because the blast wave may fail to continue past the sharp turn.

Rigid pontons. Rigid pontons are made of various materials such as wood, plastic, or metal. Most of these pontons are open, but occasionally they are decked over.

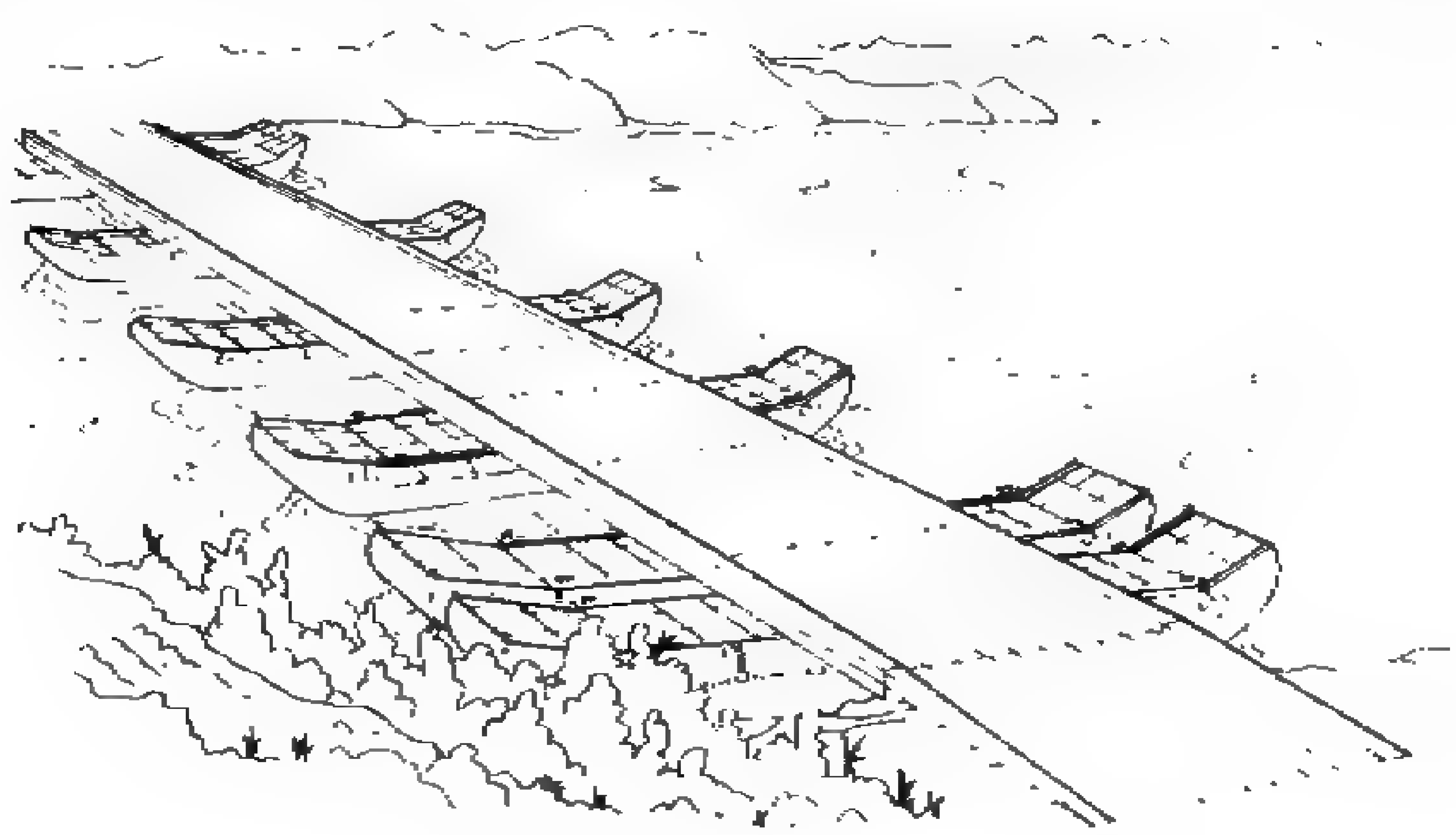


Figure 4-35. Floating bridge

Place a ½-pound charge of explosive on the upstream end of the bottom of each ponton, and detonate all charges simultaneously for a hasty method of demolition. If the current is rapid, cut the anchor cables so that the bridge will be carried downstream.

Cut the bridge into rafts, place ½-pound charges of explosives at each end of each ponton, and detonate all charges simultaneously for a deliberate method of demolition.

Treadways. Calculate the charges to destroy the treadway of any metal-treadway floating bridge by using the steel-cutting formula given in Equation (4). The placement and amount of the charges to be used depend on the type of bridge to be destroyed. Typically, if charges are set to cut the roadway completely at every other joint in the treadway, the bridge will be damaged beyond use.

Bailey Bridges

Place a 1-pound charge between the channels of the upper and lower chords to destroy the panels. A ½-pound charge will cut the diagonals, and a 1-pound charge will cut the sway bracing (Figure 4-36).

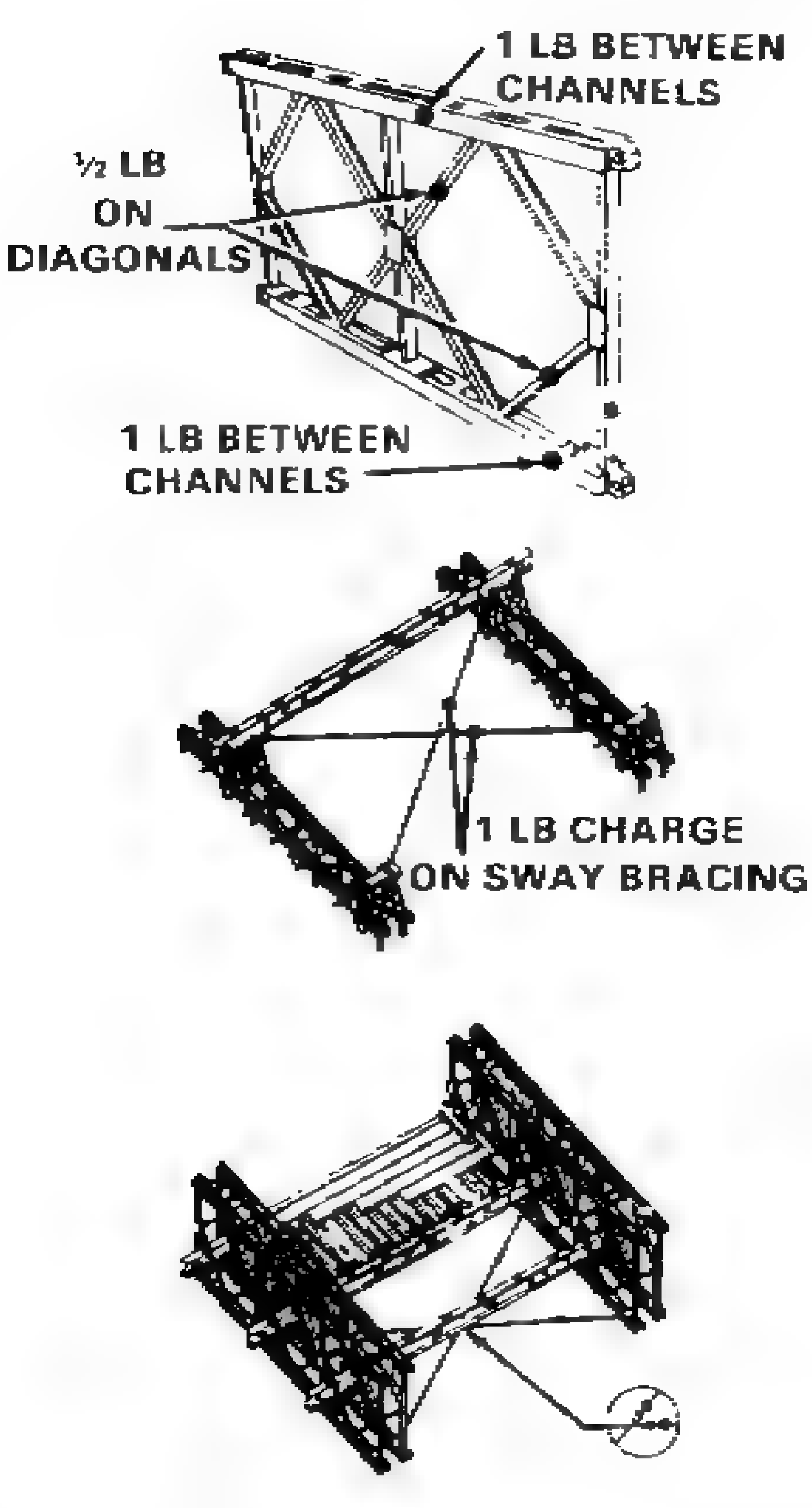


Figure 4-36. Demolition of Bailey bridge

Method of demolishing bridges in place. Cut the bridge in several sections by cutting panels on each side, including the sway braces. Stagger the line of cut through the panels; otherwise, the top chords may jam and prevent the bridge from dropping. In double-story or triple-story bridges, increase the charges on the chords at the story junction line. For further destruction, place the charges on the transoms and the stringers.

Method of demolishing bridges in storage or stockpile. Demolition of bridges in storage must be such that the enemy cannot use any of them as a unit or any parts for normal or improvised construction. This requires destruction of an essential component that is not easily replaced or improvised so the bridges at a particular stockpile cannot be used. In this way, it will also be impossible for the enemy to obtain replacements for other sectors. The component that fulfills all of these conditions is the panel. To make the panel useless, remove or distort the female lug in the lower tension chord. Destroy all panels before destroying other components.

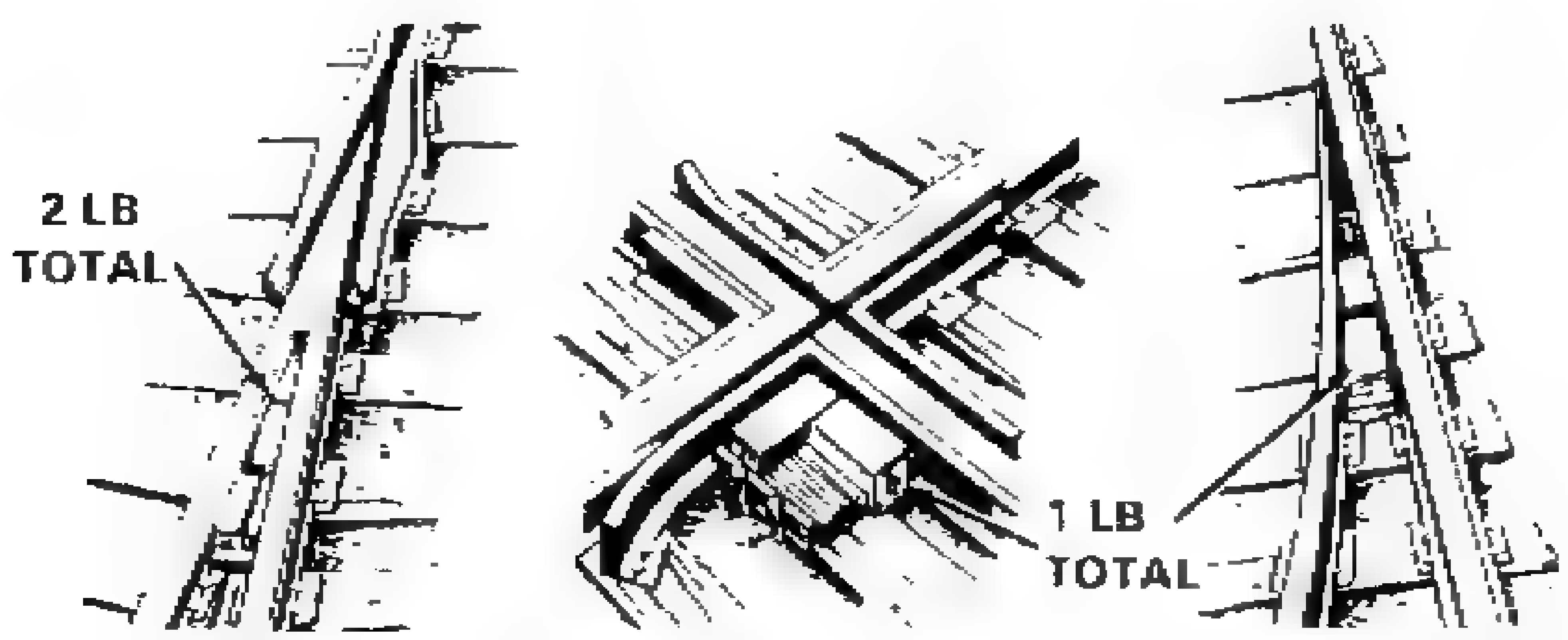
DAMAGE TO TRANSPORTATION LINES

Highways

Disruption of enemy transportation lines is an important demolition objective. The extent of demolition, however, depends on the analysis of the system and the mission. When the road net is destroyed, the attacking forces are halted or delayed, the movement of supplies is prevented, and, frequently, new construction is required before the enemy can advance. These effects can be brought about by the demolition of bridges and tunnels, by blowing road craters, by placing wrecked equipment and debris in cuts and defiles, and by the construction of abatis and roadblocks.

Railroads

Tracks. The destruction of railroads with explosives should be done at vulnerable points. These are curves, switches, frogs, and crossovers, which may be destroyed with a small amount of explosive. This is called the *spot method.* Placement of charges is shown in Figure 4-37.



Note: Use ½ lb for rails less than 5 in high. Use 1 lb for rails 5 in high or over

Figure 4-37. Demolition of railroad switches, frogs, and crossovers

Destroy a length of single track by using a detail of soldiers with a pushcar, ¼-ton truck, or other vehicle supplied with explosives, nonelectric blasting caps, time blasting fuses, fuze igniters, and filled sandbags. Several soldiers ride the vehicle, prime 1 pound charges, and hand them, together with sandbags, to the soldiers walking immediately behind the vehicle. These soldiers will place the charges against the rail on alternate connections of both tracks for a distance of about 150 meters, and tamp them with sandbags. Tamping is not required to break the rail but will destroy a longer length of rail. Other soldiers should follow about 250 meters behind the vehicle to light the fuses. This method requires approximately 20 pounds of explosive per 150-meter length of single-track line. It should be repeated at approximately 2.4-kilometer intervals. This procedure is particularly advantageous when time or other factors prohibit complete destruction of a line. It causes a greater delay in repair than a concentrated destruction of short lengths of track. If time, explosives, and other conditions permit, however, complete destruction of long lengths of track will provide the longest delay.

Make tracks unserviceable without the use of explosives by tearing up sections of the track, especially along cuts, fills, or embankments where the use of reconstruction equipment is restricted and work areas are limited. Tear up tracks by removing fishplates from both ends of a section of track, fastening a heavy chain or cable to it, and pulling it up by a locomotive. Also, a large hook towed by a locomotive is useful to tear up ties and rails. Whenever possible, pile and burn ties loosened from the rails.

Roadbeds. Damage roadbeds by using the methods in making road craters and antitank ditches.

Rolling stock. The destruction of rolling stock, particularly locomotives, will eventually cause even greater disruption of rail communications.

Railway and Highway Tunnels

Railway and highway tunnels located on major routes to strategic industrial or military areas are vulnerable to demolition and are therefore desirable targets. Tunnel demolition, however, with hastily placed conventional explosives is impractical unless huge quantities are used. But when demolition chambers exist or when time, personnel, and equipment are available, considerable damage can be done to tunnels with reasonable amounts of explosives (Figure 4-38).

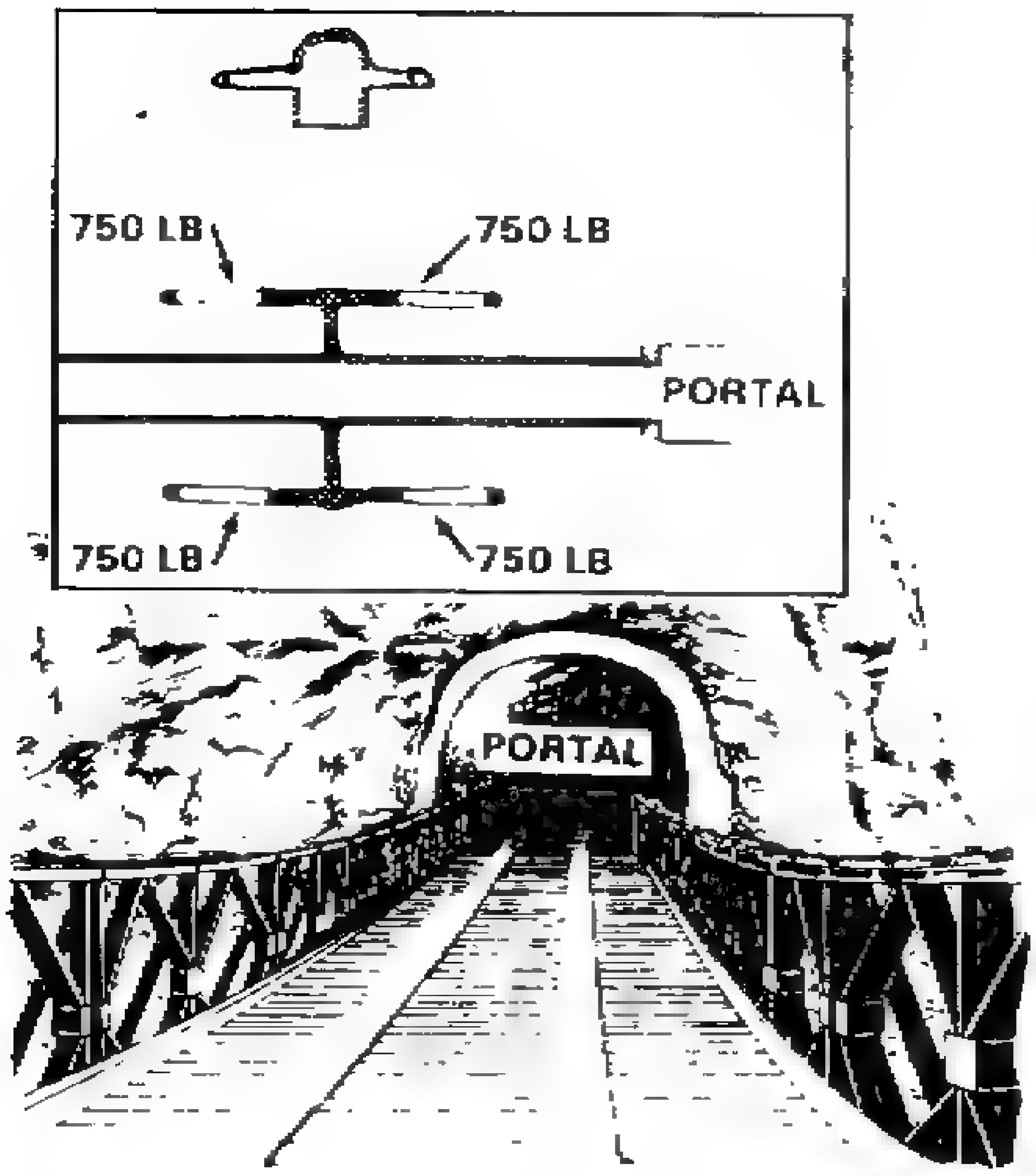


Figure 4-38. Typical concrete-lined tunnel

Principle factors in tunnel demolitions. The most critical factor in tunnel demolition is the type of rock through which the tunnel is constructed. The object of tunnel destruction by demolitions is to block the tunnel with rock and to collapse the tunnel, if possible. The best results are obtained if the tunnel is constructed in soft or medium-hard rock. In tunnels built in hard rock formations, it may be difficult to achieve a massive cave-in. Examine the tunnel lining for an indication of the type of rock through which the tunnel is built. A thin or missing tunnel lining indicates a hard rock formation.

Method of hasty demolitions. The hasty demolition of tunnels with reasonable amounts of conventional high explosives is ineffective. A hasty method that will cause extensive damage is still being developed. The enemy may be temporarily deprived the use of a tunnel by breaking and dislodging portions of the lining with breaching charges placed at a number of points or by creating slides at the tunnel portals by placing cratering charges in the slopes above them. Nuclear devices of the proper size and placed effectively will demolish a tunnel.

Methods of deliberate demolitions. Deliberate tunnel demolitions will produce satisfactory results when explosive charges are detonated in prepared chambers in the material adjacent to the inner face of the tunnel, whether it is lined or not. Excessive charges are not required. The most damage desired in any tunnel is its obstruction with broken rock. Caving, which may result from structural damage to the tunnel arch, cannot be predicted. To obtain maximum damage to tunnels, the methods described in the next three paragraphs are adequate.

Construct tunnel charge chambers so each chamber parallels the long axis of the tunnel at or above the spring line (Figure 4-38). The T-design tunnel charge chamber is an efficient means of inflicting serious damage. Construct the chambers, opposite each other, at staggered intervals on opposite sides or all on one side of the tunnel. The maximum burden, which is the distance from the charge to the inside rock wall, should be 15 feet. The tunnel charge chamber should be no larger than necessary for convenience of construction and loading and no smaller than 3 feet wide by 4½ feet high. Construct charge chambers far enough inside the tunnel to ensure confinement of the charge. The minimum of sidehill or outside burden should be 30 feet.

An effective minimum charge for single placement within a T-type chamber of 15-foot burden is 750 pounds of high explosive. Place charges on 30-foot centers.

Stemming the material with which a borehole or charge chamber is filled or tamped—usually earth-filled sandbags—is necessary. Extend the stemming from the last charge in the T-type chamber to the chamber entrance. Stemming is not necessary between charges within the chamber.

Method of deliberate demolition of tunnels with prepared charge chambers. Some tunnels have chambers or holes in the roof or walls, as described above, for the purpose of demolishing them at some future time. Their presence is usually indicated by the open brick ventilators covering them. If no ventilators are present, locate these chambers by striking the roof and walls of the tunnel with a heavy metallic object which usually produces a hollow sound. Some tunnels may also have prepared charge chambers accessible from the outside of the tunnel. These are usually designed for the destruction of the tunnel portals and may be vertical or horizontal shafts dug in the slopes above the portals. Place explosives, compacted as tightly as possible, in the chambers. Close and seal the chambers except for the place where the fuse or firing wire passes through.

Water Transportation Systems

The extent of demolition depends largely on the mission, materials available, and an analysis of the system to find out how critical, accessible, repairable, and vulnerable it may be.

Vessels, piers, and warehouses. Unless they are tied up at docks or piers, vessels can seldom be destroyed efficiently by land-based troops. Docks, piers,

and warehouses, however, are excellent demolition targets, especially with the use of fire.

Channels. The best way to block a channel is to sink a ship or a loaded barge at a point that cannot be bypassed. Block channels with retaining walls effectively by detonating breaching charges behind the retaining walls.

Dams. Since a prohibitive amount of explosive is generally required to destroy an entire dam structure, the best method is to destroy the machinery and the equipment. If the purpose of the demolition is to release the water in the dam, destroy the gates on the crest of the dam, or destroy the penstocks or tunnels used to bypass the dam or to carry water to hydroelectric plants. Another way to release the water in the dam is to destroy the valves or gates used to control the flow in the penstocks or tunnels. In dams partly or wholly constructed of earth fill, it may be possible to ditch or crater below the existing waterline and thus allow the water itself to further erode and destroy the dam. Nuclear devices can also be used to advantage.

Canals. In most cases, destroying the lock gates and the operating mechanisms that control them makes a canal useless. This mechanism, which includes the electrical equipment and perhaps pumps, is easier to destroy and should therefore be attacked first. If time permits, destroy the gates. Destroy the lock walls and canal walls by placing breaching charges or cratering charges behind them.

Airfields

Destroy airfields by atomic demolition munitions (ADM). Make airfields unusable by cratering runways or placing objects on the surface to prevent use by aircraft. The destruction of petroleum, oil, and lubricants (POL), munitions stocks, and repair and communications facilities is also desirable. Ditch runways that are not constructed of concrete by using rooters, plows, and bulldozers. Destroy friendly airfields only in areas where the resulting wreckage will impede enemy movement and operations the most. Make them ready for demolition only during the preparation for an organized withdrawal when seizure by the enemy is imminent.

Method of demolition. The methods of destroying an airfield depend on the materials at hand, the type of installation to be destroyed, and the time and equipment available to complete the job. Destroy aircraft and equipment by directing weapons fire against them. Whenever possible, use bombs and ammunition as explosive charges. (See Appendix B.) Use gasoline and other fuels (POL products) to aid in the destruction by fire of vehicles, equipment, and buildings. When time permits, prepare a detailed plan for demolition of the airfield before placing any charges. The plan should include—

- Location of charges.
- Type of explosives.
- Size of each charge.

- Priority in preparation and placement of each charge.
- Total amount of itemized explosives and other materials needed to effect demolitions included in the plan.
- Assignment of personnel or groups to prepare specific charge.

Priorities for demolition. It is seldom possible to destroy an airfield completely because of the great amount of explosives and time required. It is necessary to determine what specific demolition is to be done and in what order specific operations are to be carried out. Airfield demolition plans should be very flexible, particularly in regard to priorities. The order of priority should vary according to the tactical situation. The following list suggests an order of priority for airfield demolition. It can be modified to suit the tactical situation.

- Runways, taxiways, and other landing areas.
- Routes of communication.
- Construction equipment.
- Technical buildings.
- Supplies of gasoline, oil, and bombs.
- Motor vehicles and unserviceable aircraft.
- Housing facilities.

Runways and taxiways. Runways and taxiways have first priority in a demolition plan because the destruction of landing surfaces is the most important single item. Whenever possible, consider demolition of an airfield during construction by placing large conduits in all fills. This requires little extra work and provides a means of placing explosives under the runway. Standard deliberate and hasty craters may be useful in the demolition of runways and taxiways. Use shaped charges to breach thick concrete pavement when speed is essential. Placing individual cratering charges diagonally down runways or taxiways, or in a zigzag line running diagonally back and forth, provides complete destruction. When pierced steel planks or other types of landing mats are used on an airfield, substantial damage can be done by attaching a large hook to sections of the mat and pulling it out of place with a tractor. This should be followed by cratering. Produce a hasty obstacle by using 40-pound cratering charges spaced every 15 feet across the runway and buried 4 feet under the ground.

Turf surfaces and pavements. Destroy bituminous surface treatments or thin concrete pavements by using bulldozers, graders, and rooters. Destroy turf airstrips by plowing or cratering.

Aircraft. Destroy unserviceable aircraft by detonating 4 pounds of TNT placed on each crankshaft between the propeller and the engine and 1 pound of TNT placed on the instrument panel to prevent salvage. Destroy the engines of jet-propelled aircraft by detonating charges on essential parts, such as the compressor, air intake, or the exhaust turbine. Remove or destroy radio equipment, bombsights, radar, and tires.

Pipelines

The most vulnerable points of a pipeline system are the storage tanks and pumping stations.

Storage tanks. Destroy storage tanks filled with fuel by burning with incendiary grenades or a burst of .50-caliber incendiary ammunition. Destroy empty tanks by detonating charges against the base.

Pumping stations. Destroy booster pumping stations on cross-country pipelines. Insert gravel or other solid objects into the pipeline while the pumps are running to damage the moving parts, although not to the degree possible with explosives. If time permits, burn the pumping station after the equipment has been destroyed by explosives.

Pipe. The pipe used in pipelines can be destroyed only during scorched-earth operations because of the great amount of effort necessary for effective damage. Junctions, valves, and bends are the most suitable points, particularly when the line is buried. Another method is to close all valves on the line. The expansion that occurs even in subzero weather will break it.

DAMAGE TO COMMUNICATION SYSTEMS

Telephone and Telegraph Lines

Although damage to an enemy telephone system or telegraph system may never be extensive, it does have a great delaying effect. Telephone and telegraph switchboards and instruments are the best points of attack. Usually, 1-pound charges placed on the cables are adequate to cut them. Also, dial systems may be damaged by smoke from burning oil. Pole lines are not satisfactory targets since they are strung over long distances and can be destroyed only in spots. They can be made temporarily useless by cutting or grounding the wires or by cutting the poles with small external timber-cutting charges and then burning. Cut the wire into short lengths to prevent further use

Radio Installations

Radio provides rapid communication between distant points that would otherwise be without communication. Antenna towers, usually constructed of steel and braced with guy wires, are the most accessible parts of any radio installation. Destroy them by cutting the guy wires and placing cutting charges against the base. Topple the towers over the transmitter station or across the high-voltage transmission line through which the installation receives its power. Destroy equipment and standby power units by mechanical means or by demolition charges. Transformers are also very vulnerable. Provided they do not have automatic thermostatic cutoff switches, they will burn themselves up if a hole is blasted in the side or bottom and oil drains out.

DESTRUCTION OF BUILDINGS AND INSTALLATIONS

Buildings

The methods used and the extent of demolition usually depend on the time available.

Masonry or concrete buildings. Destroy masonry or concrete buildings by placing breaching charges on the inside and at the base of the exterior walls.

Wood or thin-walled buildings. Destroy wooden-frame or thin-walled buildings by fire. Another method is to close all doors and windows and explode on the ground floor a concentrated charge (dust initiator) equal to ¼ pound to 1 pound of explosive per cubic yard of volume. For further information, see Appendix C. You can also dismantle such buildings, if time permits.

Steel-framed buildings. Destroy buildings with steel frames by first breaching the concrete or masonry where necessary to expose the vital steel members and then cutting them with explosive charges. Another method is the exposure of the interior to extreme heat (1,000 degrees Fahrenheit for 10 minutes); this will cause failure of the structural steel members.

Concrete-beam and curtain-wall buildings. Destroy concrete-beam and curtain-wall buildings (constructed in such a way that the load is carried by reinforced-concrete beams and columns) by placing breaching charges inside the buildings at the base of the exterior wall and at the base of all intermediate columns on the ground floor.

Electrical Power Installations

Electrical power plants. Before destruction, study electrical power plants so that the amount of damage will be adequate but will not exceed tactical demands. Destroy them by cutting the windings of generators and motors, by placing and detonating a 2-pound charge inside the casings, or by pouring gasoline on the generators and lighting them. Short out generators by using metal powders or shavings. Break the shafts of motors and generators. Remove or contaminate the lubricating oil with metal filings or aluminum powder and then run the machinery. Burst boilers with a cutting charge. Destroy all buildings, transmission towers, penstocks, and turbines of hydroelectric plants.

Transmission and distribution facilities. Destroy transmission lines by cutting or by demolishing the towers or poles. However, the complete disruption of electrical power by this method is difficult since electrical power is usually supplied by more than one power line. Attack electrical substations by destroying transmission lines and switching equipment. Large transformers are very vulnerable. They will burn themselves up if the cooling oil is drained out. This draining can be accomplished by using explosives or weapons fire.

NOTE: Electrical firing systems should **not** be used.

Water Supply Systems

The pumping station, filtration plant, and reservoirs of a water supply system are usually the most accessible points to attack. Destroy storage tanks by charges calculated on the basis of 1 pound of explosive per 100 cubic feet of capacity. Detonate the charge inside the tank when it is full of water. The water will act as a tamping material. Shaped charges are also useful in this capacity. However, the standoff should be cut down considerably. Wells sunk in soft soils are damaged beyond repair by charges that cut the lining. Destroy wells in rock and hard soils with little or no lining by exploding large breaching charges 6 to 12 feet from the edge of the well and deep enough to secure good tamping. If time does not permit such preparation, explode a large charge halfway down and against the side of the well.

Refineries

Petroleum, oils, and lubricants (POL) refineries are readily demolished since they have such extremely vulnerable points as cracking towers, steam plants, cooling towers, and POL stock. These points are easily damaged by using explosive charges and fire. The demolition of such installations should be planned and executed only by persons familiar with their design and construction or after extensive investigation.

DESTRUCTION OF FORTIFICATIONS

Overview

The destruction of field fortifications to prevent their use or reuse by enemy forces, as with all other demolition projects, depends on the material from which they are constructed and the time, equipment, material, and personnel available. As field fortifications are of many types ranging from observation towers to underground bunkers and may be constructed of many types of materials that range from earth-filled sandbags to reinforced concrete, the calculation of a standard method for destruction by use of explosives is almost impossible.

Bunkers

Aboveground or semiburied. Bunkers that are aboveground or partially aboveground are accessible to personnel and can be dismantled or collapsed by heavy equipment. Use explosives to breach the roof of the bunker or to cut the structural members that support the roof.

Underground. Bunkers that are completely below the ground are best destroyed with explosives. Place the explosives to breach the ceiling of the bunker or cut the structural support of the ceiling. If time permits, the construction and use of demolition chambers similar to those used in railway and highway tunnel destruction may be advantageous.

Trenches

Fill trenches by hand or with equipment. The use of explosive charges to collapse the walls may be required when trench walls are supported with timber or other materials. However, large quantities of explosives may be required.

Tunnels and Caves

Caves. Destroy caves by collapsing the wall and ceiling or the entrance using the methods outlined for highway and railroad tunnel destruction.

Tunnels. Tunnels used to connect underground bunkers can be collapsed along their entire length or partially destroyed by collapsing the tunnel entrances. Because tunnels can vary in size and construction and the soil conditions vary widely even within the same tunnel, the use of test shots is necessary. For unlined tunnels in earth and not over 2 meters in diameter, a rule of thumb may be used to find the amount of explosive needed for a test shot. The rule is to use 2 pounds of explosive per linear foot of tunnel for 10 feet or less of *overburden,* which is the depth of earth above a tunnel. For each additional 10 feet or less of overburden, an additional 2 pounds of explosive per linear foot of tunnel are recommended. Distribute the explosive charges along the entire length, and tie them together with detonating cord. For maximum destructive effect, place charges against the ceiling and fill in all tunnel entrances. The use of additional explosives at turns, intersections, and branches of the tunnel may be necessary. If the size and construction of the tunnel and local soil conditions vary from those described, adjust the amount of explosives used for the test shot.

DESTRUCTION OF EQUIPMENT AND SUPPLIES

Overview

Whenever the destruction of equipment and supplies is undertaken, some basic considerations are to be factored in and priorities established. Also, the proper level authority must authorize the action.

Authority for destruction. The destruction of friendly material is a command decision, carried out only on the authority of the division or higher commander. Destroy or make unserviceable equipment and supplies that cannot be evacuated and can, therefore, be captured by the enemy except for medical materials and stores, which are not to be intentionally destroyed (DA Pam 27-1 and TM 750-244-3).

Destruction areas. Whenever possible, destroy mobile equipment in places where it most effectively impedes the advancement of the enemy. Examples of such places are approaches to bridges (fills); airfield landing strips; cuts, fills, or hills on roads; sharp bends of roads; roads leading through densely wooded areas; and narrow streets in thickly populated or built-up areas.

Priority of operations. Destruction can only be as complete as the time, equipment, and personnel available will permit. If all parts of the equipment cannot be completely destroyed, damage the most important ones. Give special attention to those parts that are not easy to duplicate or rebuild. Take particular care to destroy the same components on each piece of equipment. Otherwise, the enemy can cannibalize equipment by assembling a complete unit with parts taken from several partly destroyed units.

Precautions. When material is destroyed by explosives or by weapons fire, flying fragments and ricocheting bullets create a hazard. Thus, demolition must be done in an area free of friendly troop concentrations.

Planning

Standing operating procedures for all units should contain a plan for the destruction of all equipment and except medical supplies. (They are left intact for friendly use.) Such a plan should do two things. It should ensure that the most effective damage is done to the material and that the use of friendly equipment is denied to the enemy. The plan should outline the required extent of demolition and include priorities of demolition and methods of destruction for all items issued to the unit. If explosives are to be used, note the required amounts on the plan. The plan must be flexible enough to meet any situation. To make cannibalization by the enemy impossible, familiarize each equipment operator with the order in which essential parts, including extra repair parts, are to be destroyed. Each operator must also be familiar with the sequence to be followed for total destruction.

Methods of Destroying Material

The methods of destroying material described can be used either singly or in combination. The actual methods used in a given situation depend on the time, personnel, and means available.

Explosives. All military explosives are effective in destroying equipment.

Mechanical means. To destroy material by mechanical means, use sledge-hammers, crow bars, picks, axes, and any other available heavy tools to smash or damage whatever is to be destroyed.

Weapons fire. Hand grenades, rifle grenades, antitank rockets, machine-gun fire, and rifle fire are valuable means of destroying material.

Thermite grenades. Destroy or make unserviceable flammable material and equipment by heat generated by the thermite grenade. Soak the material with fuel before burning.

Fire. Pack rags, clothing, or canvas under and around the material to be burned. Soak the rags or clothing with gasoline, oil, or diesel fuel. Damage from fire may not always be as severe as expected. Engine or transmission parts heated to less than a dull red heat are not seriously damaged if they are lubricated immediately after the fire to prevent corrosion. Destroy electrical equipment, including motor or generator armature windings and other wiring, by burning. All parts made from low-melting-point metal can be almost completely destroyed by fire.

Water. An easy and quick method of damaging equipment is to submerge it, but the damage is not usually severe. Total submersion conceals equipment.

Abuse. Deliberately operating equipment improperly damages it severely, especially engines. Such abusive treatment can proceed even after abandonment by draining the oil, then leaving the engine running at a high idle speed.

Concealment. Remove accessible vital component parts of equipment, and scatter them through dense foliage, preventing or at least delaying use by the enemy. Hide vital parts of entire items by throwing them into a lake, stream, or other body of water.

Booby traps. Place booby traps in debris after destruction is completed, if time permits. See FM 5-31 for the techniques.

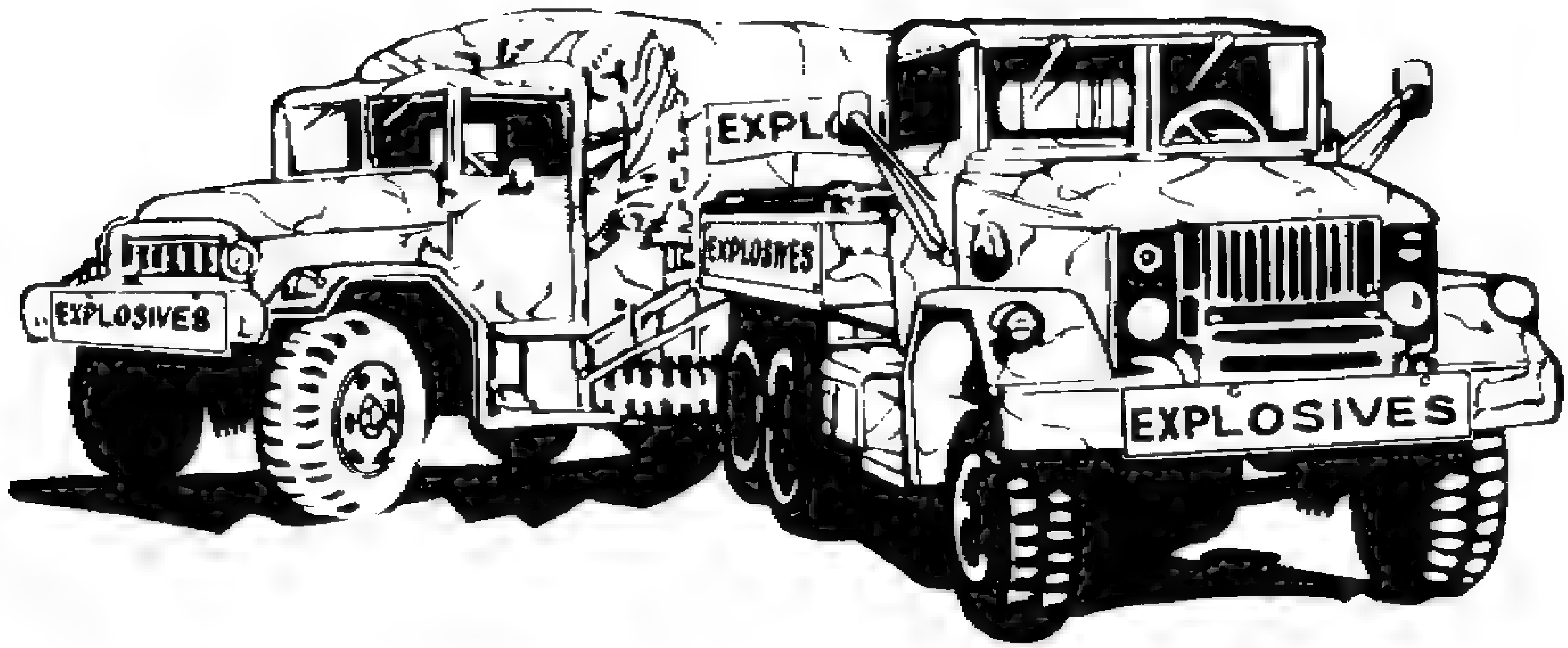
Destruction of Combat Equipment

There are various publications on the proper method of destroying military combat equipment. For additional information regarding the destruction of small arms such as rifles, mortars, and ammunition, see the references for a listing of the FM 23 series. For additional information about the destruction of armored vehicles and their weapons, see the references for a listing of the FM 17 series. For destruction of demolition material, see Chapter 5 of this manual.

Training

Training involves the simulated breaking of vital parts, the placing of dummy charges, and the selection of sites suitable for the destruction of equipment in order to block communication routes. It does not involve the actual demolition of any material. Drivers and operators should know each step in the appropriate method for the destruction of their equipment and supplies. The methods of destruction, which are preferred in the order given, are to cause mechanical damage to vital parts; to use explosives; and to employ water, fire, and weapons fire.

safety factors 5



Safety is of great importance when working with explosives. Specific procedures thus exist for their handling, transporting, storing, and destruction. This chapter deals with safety precautions and responsibility for carrying out safety procedures. It also presents methods for destroying explosives to prevent enemy use.

GENERAL SAFETY PRECAUTIONS

Safety Rules and Responsibility

Compliance. During training, safety rules regarding explosives, caps, and demolition equipment will be followed strictly. In combat, some safety rules may change so that unit missions can be carried out. In all other situations, safety rules will be observed to the fullest extent permitted by time, materials available, and requirements of the mission. Post regulations and local and unit standing operating procedures (SOPs) will also be observed.

Responsibility. Do not divide the responsibility for preparing, placing, or firing of charges. One individual should be responsible for the supervision of all phases of the demolition mission.

Safe Distance from Demolitions

Blast effect. Missiles thrown by an explosion are a greater danger to personnel than the blast effect (an increase in air pressure). The blast effect is a hazard only on occasions when special protective features are used at detonation or demolition sites to eliminate flying debris or confine missiles and to provide for detonation of charges close to personnel. Personnel who are provided the minimum protection prescribed will not generally be endangered by blast effects (AR 385-63).

Missile hazard. Explosives can propel lethal missiles great distances. How far an explosion propelled missile will travel in air depends primarily on the relation between weight, shape, density, initial angle of projection, and initial speed. The missile hazard from steel-cutting charges extends a greater distance under normal conditions than that from cratering, quarrying, or surface charges of bare explosives.

Safe distances. The following criteria give distances at which personnel in the open are relatively safe from missiles created by bare charges placed in or on the ground, regardless of the type or condition of the soil (AR 385-63).

For charges weighing less than 27 pounds, the minimum missile hazard distance is 300 meters.

For charges weighing more than 27 pounds, the distance at which personnel in the open are relatively safe from missiles can be calculated from the following formula:

$$\text{Safe distance (in meters)} = 100 \times (\text{lb explosive})^{1/3} \qquad (15)$$

Safe distances calculated for selected charge weights are listed in Table 5-1.

Problem—Determine the safe distance if 200 lb of TNT are used.

Solution—Solve the problem presented as follows:

$$\begin{aligned}\text{Safe distance} &= 100 \times (200)^{1/3} \\ &= 100 \times 5.85 \\ &= 585 \text{ meters}\end{aligned}$$

For charges placed to demolish solid material, locate missile-proof shelters a minimum distance of 100 meters away from the demolition site. These shelters should be strong enough to withstand the heaviest material that might be thrown on them.

Table 5-1. Minimum safe distance for personnel in the open

Explosives		Safe distance,	Safe distance,	Explosives		Safe distance,	Safe distance,
kg	lb	m	ft	kg	lb	m	ft
45 to 12.3	(1 to 27)	300	(900)	68 0	(150)	534	(1,590)
13.6	(30)	311	(930)	79.8	(175)	560	(1,680)
16.3	(35)	327	(980)	90.7	(200)	585	(1,750)
18.1	(40)	342	(1,020)	102.4	(225)	609	(1,820)
20 8	(45)	356	(1,070)	113.8	(250)	630	(1,890)
22.7	(50)	369	(1,100)	125.9	(275)	651	(1,950)
27 2	(60)	392	(1,170)	125.1	(300)	670	(2,000)
31.8	(70)	413	(1,240)	147.8	(325)	688	(2,070)
36 3	(80)	431	(1,290)	158.8	(350)	705	(2,100)
40.8	(90)	449	(1,330)	170.5	(375)	722	(2,160)
45.4	(100)	465	(1,390)	181.4	(400)	737	(2,210)
57 1	(125)	500	(1,500)	193.2	(425)	750	(2,250)
				226.8	(500)	800	(2,400)

For charges over 226.70 kg (500 lb),
distance in feet = 300 $\sqrt[3]{\text{Pounds of explosives}}$

Safe distance in meters = 100 x $\sqrt[3]{\text{Pounds of explosive}}$

Minimum distance for personnel in a missile-proof shelter is 91 4 m (300 ft).

Package Care and Repair

Carelessness, rough handling, and disregard for safety rules may cause premature explosions, misfires, and in many cases, serious accidents. Pack issued explosives and auxiliary items in moisture-resistant containers and proper packing boxes to withstand field conditions of transportation and storage. Do not handle containers and boxes roughly; they must never be broken, cracked, or dented. Some special items, if distorted, lose part of their effectiveness. Repair damaged packing boxes and containers immediately. Transfer all defaced parts of marking to new parts of the boxes. Destroy broken airtight containers, such as those containing chemical mines. For detailed information on care and handling of explosive items, see TM 9-1300-206.

Reports of Malfunction

Identify explosives by lot number. If frequent misfires or failures and malfunctions occur, note the lot number of the malfunctioning item and report the incident in accordance with AR 75-1.

TRANSPORTATION AND STORAGE

Transportation Regulations

When transporting military explosives and other dangerous military articles, military or commercial carriers within the United States are subject to the same laws and rules. Army Regulation 55-228 governs transportation by water of military explosives, flammables, and chemical materials. Technical Manual 9-1300-206 contains minimum safety requirements for handling and transporting military explosives and ammunition. Everyone involved in transporting explosives must learn local procedures and proper safety requirements and will be held responsible for all violations of those procedures.

Safety Rules

Whenever explosives are transported for local use, observe the safety rules that follow:

- Never mix live and dummy (training) explosives together. This includes mixing for the purpose of demonstration or training purposes
- Vehicles used for the transportation of explosives shall not be loaded beyond rated capacity. Secure the explosives to prevent shifting of the load or dislodgement from the vehicle in transit. In all open-body vehicles, cover the explosives with a fire-resistant tarpaulin.
- Mark all vehicles transporting explosives with reflectorized placards on both sides and ends.
- Do **not** transport blasting caps or other initiators in the same vehicle with other explosives, if possible. If not possible, carry the caps in the front of the truck within a closed metal can and carry the explosives in the rear.
- Do **not** carry metal tools, carbides, oils, matches, firearms, electric storage batteries, flammable substances, acids, and oxidizing or corrosive compounds in the bed or body of any vehicle transporting explosives.
- Vehicles used in the transportation of explosives shall be in good repair. When steel or part-steel bodies are used, fire resistant and nonsparking cushioning materials will be used to separate the containers of explosives from the metal.
- Equip vehicles transporting explosives with not less than two fire extinguishers placed at strategic points, filled and ready for immediate use, and of a make approved by the National Board of Fire Underwriters for class B and C fires.
- Do **not** take a vehicle containing explosives into a public building or repair shop. Do **not** park in congested areas.
- Check all vehicles before transporting explosives, and protect and securely fasten all electrical wiring to prevent short circuiting.
- Operate vehicles transporting explosives with extreme care. Do **not** drive at a speed greater than 35 miles per hour. Make full stops at approaches to all railroad crossings and main highways, and do not proceed until the way is clear. This does not apply to convoys or protected crossings where guards or highway workers with flags are stationed.

- All vehicles transporting explosives on public highways, roads, or streets will have an authorized operator and assistant operator. No person other than the authorized driver and helper will be permitted to ride on a truck transporting explosives. No motor vehicle will be refueled while explosives are on the vehicle except in an emergency.

Magazines

Types. Store explosives in magazines according to the safety regulations prescribed in TM 9-1300-206 and FM 9-6. Table 5-2 shows the minimum distance for the location of magazines from other magazines, buildings, and routes of communication based on the quantity of explosives stored. There are two types of magazines—permanent and temporary. Although the permanent type is preferred, temporary or emergency types are frequently required when permanent construction is not possible.

Table 5-2. Magazine locations (unbarricaded)

Quantity of explosives, lb (not to exceed)	Minimum distance, in ft, from nearest—		
	Inhabited building	Public highway and public railroad	Magazine
50	300	180	60
100	380	230	80
500	640	380	140
1,000	800	480	190
2,000	1,010	610	230
4,000	1,270	760	280
6,000	1,460	880	320
8,000	1,600	960	360
10,000	1,730	1,040	400
20,000	1,950	1,170	490
40,000	2,550	1,530	620
60,000	3,030	1,820	700
80,000	3,390	2,035	780
100,000	3,630	2,180	830
200,000	4,060	2,435	1,050
500,000	5,410	3,245	1,430

Note. For more detailed information see TM 9-1300-206.

Barricades. Barricade explosives storage magazines; that is, there must be a substantial obstacle between them and inhabited buildings. For certain explosives, effective natural or artificial barricades reduce the required distance between magazines, railways, and highways by one half. The use of barricades permits the storage of larger quantities of explosives in any given area. Although barricades help protect magazines against explosives and bomb or shell fragments, they do not safeguard against pressure damage. Specific details on barricades are outlined in TM 9-1300-206.

Alternatives. Place magazines at locations determined according to safety, accessibility, dryness, and drainage. Safety and accessibility are the most important. An ideal location is a hilly area where the height of the ground above the magazine provides a natural wall or barrier to buildings, centers of communication, and other magazines in the area. Sidehill dugouts are not desirable since adequate ventilation and drainage are often hard to provide. Clear brush and tall grass from the site to lessen the danger of fire.

Lightning protection. All magazines must have a grounded overhead lightning rod system. Connect all metal parts—namely, doors, ventilators, window sashes, and reinforcing steel—in several places to buried conduits of copperplate or graphite rods.

Field Expedient Structures

Storage. When magazine construction is not possible, place explosives on pallets for all-around ventilation and store in—

- A well-drained dugout, excavated in a dry area and revetted with timber to prevent caving.
- An isolated building.
- A light wooden-frame box house with a wedge-type roof covered by corrugated iron or with a tent or canvas tarpaulin.

Identification. Mark field expedient storage facilities by using signs on all four sides, and guard the facility.

Temporary Magazines and Storage

When necessary, limited supplies of explosives can be stored for several days in covered ammunition shelters that are separated so that fire or an explosion cannot be transmitted from one shelter to another. Piles of explosives temporarily stored in the open should contain no more than 500 pounds and should be placed no less than 140 feet apart. Pile explosive components separately. Keep explosives, caps, and other demolition materials stored temporarily in training areas in covered ammunition shelters and under guard at all times. Temporary storage operations should be guided by local safety SOPs and other regulations prescribed in TM 9-1300-206.

DESTRUCTION TO PREVENT ENEMY USE

Overview

To prevent enemy use of explosives and demolition materials, specific procedures must be followed. Destruction of demolition materials is a unit command decision; whenever destruction orders are given, site selection and safety precautions are factors to be taken into account.

Demolition procedures. Destroy damaged or unserviceable explosives and demolition materials by explosive ordnance disposal units as specified in AR 75-14, AR 75-15, TM 43-0001-38, and FM 9-16.

Captured or abandoned demolition material. Demolition material that may be captured or abandoned will be destroyed by the unit when the unit commander decides it is necessary under the orders or policy of the Army commander. Such destruction is a command decision based on the tactical situation, security classification of the demolition materials,their quantity and location, facilities for accomplishing destruction, and time available. In general, burning or detonating, or a combination of these, is the most effective means of destruction.

If destruction to prevent enemy use is resorted to, explosive and nonexplosive demolition materials must be completely destroyed so they cannot be restored to usable condition in the combat zone. Equally important is that the same essential components of sets and kits must be destroyed so the enemy cannot assemble complete ones from undamaged components by cannibalization.

If the destruction of demolition materials is directed, items to be considered are twofold—selection of a site that will cause the greatest obstruction to the enemy's movement but will prevent hazards to friendly troops from fragments and blast plus the observation of appropriate safety precautions.

Methods of Demolition

Burning and detonating, in that order, are considered the most satisfactory methods for destroying demolition materials to prevent enemy use. Information on the destruction of explosives and ammunition can be found in TM 9-1300-206 and TM 9-1300-214.

Burning method. Destroy packed and unpacked high explosive items such as a linear demolition charge, shaped demolition charge, block demolition charge, dynamite stick, detonating cord, firing device, time blasting fuse, and similar items quickly and effectively by burning. Stack blasting caps, set aside for destruction by burning, in separate piles and not with other explosives. The burning method is done as follows:

- Stack the explosives in a pile, if possible (not over 2,000 pounds to a pile), over a layer of combustible material.
- Ignite the pile by means of a combustible train (excelsior or slow-burning propellant) of suitable length, and take cover immediately. The danger area for piles being burned in the open is calculated from the safe distances given in Table 5-1 (never less than 400 meters).

metric charge calculations

appendix a

A-1. Introduction

The following metric equivalent charge calculation formulas are included because of NATO requirements. Problems, solutions, and tables with measurements converted to the metric system are presented.

A-2. Characteristics of Demolition Charges

The characteristics of the standard US Army demolition charges, expressed in the metric system, are given in Table A-1.

A-3. Timber-Cutting Formulas

a. Tamped internal charges.

(1) Formula: $K = \dfrac{D^2}{3500}$ where,

K = kilograms of TNT required,
D = diameter of timber in centimeters, and
3500 = constant.

Table A-1. Characteristics of principal US explosives (metric)

Item	Detonating velocity, m/sec	Relative effectiveness	Weight per block, kg
TNT block, ¼ lb	6,900	1.00	.113
TNT block, ½ lb			227
TNT block, 1 lb			454
M2 block, 2½ lb, Tetrytol	7,000	1 20	1 134
M3 block, 2¼ lb, C2 or C3	7,625	1 34	1 021
M5A1 block, 2½ lb, Comp C4	8,040	1 34	1.134
M112 block, 1¼ lb, Comp C4	8,040	1 34	.567
M118 block, 2 lb, (PETN)	7,040	1.14	block —.907 kg sheet—.113 kg
M186 roll, 25 lb, (PETN)	7,040	1.14	roll - 11.34 kg sheet—744 gm per m or 1 00 kg per 1 34 m
Ammonium nitrate, 40-lb, cratering charge	3,400	0 42	18 14
M1 military dynamite, ½ lb	6,100	0 92	227
M2A4, 15-lb, shaped charge	NA	NA	6.80
M3A1, 40-lb, shaped charge	NA	NA	18.14
M183 demolition charge assembly	NA	1.34	9.07

NA – not applicable.

(2) Example: (Figure 3-1 on page 3-6)

$$K = \frac{D^2}{3500}$$

$$K = \frac{35^2}{3500} - \frac{1225}{3500}$$

$K = .350$ kg;

Use .454 kg (1 lb) of TNT

b. Untamped external charges.

(1) Formula: $K = \frac{D^2}{560}$ where,

K = kilograms of TNT required,
D = diameter of timber in centimeters, and
560 = constant.

(2) Example: A timber is 30 centimeters thick.

$$K = \frac{D^2}{560}$$

$$K = \frac{30^2}{560} = \frac{900}{560}$$

$K = 1.61$ kg,

Use 1.816 kg (4 lb) of TNT

c. Abatis charge.

(1) Formula: $K = \frac{D^2}{700}$ where,

K = kilograms of TNT required,
D = diameter of tree in centimeters, and
700 = constant.

(2) Example: A tree is 45 centimeters in diameter.

$$K = \frac{D^2}{700}$$

$$K = \frac{45^2}{700} = \frac{2025}{700}$$

$K = 2.89$ kg of TNT

$$K(C4) = \frac{2.89}{1.34} = 2.16 \text{ kg of C4}$$

Use 2.268 kg (5 lb) of (C4).

A-4. Steel-Cutting Formulas

a. Structural steel.

(1) Formula: $K = \dfrac{A}{38}$ where,

K = kilograms of TNT required,

A = cross sectional area in square centimeters, and

38 = constant.

(2) Example: (Figure 3-5 on page 3-11)

Flange Area = 2 x 1.3 x 12.7 = 33.02 sq cm or 33 sq cm

Web area = 1 x 28 = 28 sq cm

A (total) = 33 + 28 = 61 sq cm

$$K = \frac{A}{38} = \frac{61}{38}$$

K = 1.61 kg

Use 1.816 kg (4 lb) TNT.

b. Formula for other steels.

(1) Formula: $K = \dfrac{D^2}{14}$ where,

K = kilograms of TNT required,

D = diameter of section to be cut in centimeters, and

14 = constant.

(2) Example: A steel shaft is 5 centimeters in diameter.

$$K = \frac{5^2}{14} = \frac{25}{14}$$

K = 1.786 kg

Use 1.816 kg (4 lb) TNT.

c. Table of steel-cutting charges. Table A-2 gives the correct weight of TNT necessary to cut structural steel sections of various dimensions calculated from the formula $K = \dfrac{A}{38}$.

Table A-2. Steel-cutting charges (metric)

Average thickness of section, cm	Kilograms of TNT for rectangular structural steel section of given dimensions — Width of section, cm											
	4.0	6.0	8.0	10	15	20	25	30	35	40	50	60
0.5	.06	.08	.11	.13	.20	27	.33	.40	46	53	.66	79
1.0	.11	.16	.21	27	.40	.53	.66	.79	.93	1 06	1.32	1 58
1.5	.16	24	.32	.40	60	.79	99	1.19	1.39	1.58	1.98	2.37
2.0	.21	.32	42	.53	79	1.06	1.32	1 58	1.85	2.11	2.64	3.16
2.5	.27	.40	.53	66	.99	1.32	1.65	1.98	2.31	2.64	3.29	3.95
3.0	32	.48	.64	.79	1.19	1.58	1.98	2.37	2.77	3.16	3.95	4 74
3.5	.37	.56	.74	93	1.39	1.85	2.31	2.77	3.23	3 69	4.61	5 53

A-5. Pressure Charges for T-Beams

Formula: $K = 48\ H^2\ T$ where,

K = kilograms of TNT required,

H = height of T-beam in meters,

T = thickness of beam in meters, and

48 = constant.

H and T are measured to nearest .10 meter, but never considered less than .30 meter.

NOTE: Minimum tamping of 30 centimeters is required. The value calculated must be increased by one third, if untamped.

A-6. Breaching Charge

a. Formula: $K = R^3\ MC$ where,

K = kilograms of TNT required,

R = breaching radius in meters,

M= material factor, given in Table A-3, which reflects the strength, hardness, and mass of the material to be demolished,

C = a tamping factor, given in Figure 3-12 on page 3-19, which depends on the location and tamping of the charge.

Table A-3. Value of material factor M calculation of breaching charges (metric)

Material	Breaching radius	M
Ordinary earth	All values	1 12
Poor masonry, shale, hard-pan; good timber and earth con struction	Less than 1.5 m 1 5 m or more	5 13 4 64
Good masonry	.3 m or less	14 09
Ordinary con-crete	Over .3 to less than 1 m 1 to less than 1 5 m	7.69 6 41
Rock	1 5 to less than 2 m 2 m or more	5.13 4.32
Dense concrete First-class masonry	.3 m or less Over .3 to less than 1 m 1 to less than 1 5 m 1.5 to less than 2 m 2 m or more	18.26 9.93 8.33 6.57 5 61
Reinforced concrete	.3 m or less Over .3 to less than 1 m 1 to less than 1.5 m 1 5 to less than 2 m 2 m or more	28 19 15 38 12 81 10 09 8 65

b. Breaching radius. The breaching radius (*R*) is the distance in meters which an explosive charge must penetrate and within which all material is displaced or destroyed. The breaching radius is rounded up to the next highest ¼-meter. For example, to breach a 2.9-meter concrete wall by placing a charge on one side, the value of R in the formula $K = R^3 MC$ is 3.0 meters.

c. Material factor. The values of the material factor (*M*) for various types of construction are given in Table A-3.

d. Tamping factor. The values of the tamping factor, *C*, depend on the location and tamping of the charge. No charge is considered fully tamped unless it is covered to a depth equal to the breaching radius. The values for *C* are given in Figure 3-12 on page 3-19.

e. Example. Determine the amount of C4 (M112 blocks) required to breach a dense concrete pier 1.5 meters thick with untamped charges placed on the ground.

R = 1.5 meters
C = 3.6 (untamped, on ground, Figure 3-12 on page 3-19).
M = 6.57 (dense concrete, Table A-3)
$K = R^3 MC$
$K = 1.5^3 \times 6.57 \times 3.6.$
K = 79.8 kg of TNT per charge
$K(C4) = \frac{79.8}{1.34}$
K(C4) = 59.6 kg of C4
Use 106 M112 blocks of C4 (60.1 kg) per charge.

use of land mines, aerial bombs, shells, and foreign explosives as demolition charges

B-1. Introduction

a. When land mines, aerial bombs, and shells are used as demolition charges, special precautions must be taken because of flying steel fragments. The use of such mines, bombs, and shells is usually uneconomical but may at times become necessary or desirable. Such material may be issued from captured or friendly supply stocks or, in the case of land mines, may be those recovered from enemy or friendly minefields. In no case should unexploded dud shells or bombs be used for demolition purposes.

b. When necessary, explosives of allied nations or those captured from enemy supply stocks may be used to supplement or used in lieu of standard explosive charges.

B-2. Land Mines

a. **Safety precautions.** Only defuzed mines should be used in demolition charges; fuzed mines recovered from minefields may be sensitive because of near misses and may be detonated by even normal handling. The use of enemy mines salvaged from minefields or dumps is regulated by directives issued from headquarters of the theater concerned. United States and foreign land mines are described in detail in TM 5-280.

b. **Charges.** In calculating demolition charges when using mines, only the explosive weight is considered. Normal explosive quantities may be used for cratering or pressure charges with mines; but, because of poor contact of the mine case against irregularly shaped objects, it may be necessary to increase cutting charges considerably. Test shots will determine the results to be obtained under given conditions. Listed are antitank mines in current use by the United States and in current use or obsolete in foreign armies with their explosive weights. Information, however, on the type of explosive used is not always available.

(1) United States

Type Mine	Explosive
M15 AT (metallic)	22 lb TNT
M19 AT (nonmetallic)	21 lb TNT
M21 AT (metallic)	10 ½ lb Comp. H6

(2) Foreign mines

(a) Belgium

PRB-4 AT	20 lb Hexogen

(b) Communist China

Dual-purpose No 4 (metallic)	4.5 lb TNT

(c) Czechoslovakia

PT-Mi-K AT (metallic)	11 lb TNT
PT-Mi-Ba AT (plastic)	12 lb TNT
Na-Mi-Ba AT (plastic)	5.3 lb Tritol
TQ-Mi AT (cardboard)	11.5 lb TNT

(d) Finland

M 36 AT (metallic)	8 lb TNT
M 39 AT (metallic)	8.8 lb TNT

(e) France

M1948 AT (metallic)	11 5 lb TNT or military dynamite (MD)
M1948 plate charge AT (metallic)	15 2 TNT or picric acid*
M1951 shaped charge AT (metallic)	4 to 5 lb kexolite
M1951 AT (caseless)	14.3 lb cast TNT
M1951 AT (plastic "grille")	11 to 16 lb PETN

(f) Japan

Model 63 Heavy AT	24.2 lb Comp. B

(g) Netherlands

Type II AT (metallic)	9 lb

(h) South Korea

Heavy AT mine (metallic)	22 lb TNT
Type I dual purpose (metallic)	5.7 lb TNT
Type II dual purpose (metallic)	4.5 lb TNT

(i) USSR

TMD-B AT (wooden)	11 to 15 lb amatol, dynammonite TNT or picric acid*
TMN 46 AT (metallic)	12.6 lb TNT
YaM-5 AT	8 to 11 lb TNT or amatol

(j) United Kingdom

Mark 4 GS AT (metallic)	8.25 lb TNT
Mark 5 GS AT (metallic)	4.5 lb TNT
Mark 5 HC AT (metallic)	8.3 lb TNT
Mark 7 AT (metallic)	19.6 lb TNT

c. Priming. Land mines are detonated by means of a pound of explosive placed on the pressure plate. If large quantities of mines are to be fired simultaneously, several mines are primed to ensure complete detonation. Detonation of a single mine normally detonates other mines in contact with it.

(*Picric acid corrodes metals, forming extremely sensitive compounds, easily detonated. Mines loaded with this explosive should **not** be handled except to move them to a safe disposal area for destruction.)

B-3. Aerial Bombs

a. Use. General-purpose aerial bombs may be used satisfactorily as demolition charges but are more effective as cratering charges. Their shape makes them inefficient for demolitions requiring close contact between the explosive and the target. Precautions must be taken to avoid damage to installations and injury to personnel because steel fragments of the bomb case are thrown great distances. Before using a bomb, it must be positively identified as a general-purpose bomb.

b. Charges. The explosive content of bombs is approximately half their total weight. Table B-1 gives the weight of high explosive in various types of general-purpose bombs. Approximately 20 percent of the explosive power is expended in shattering the case.

c. Priming. Bombs under 500 pounds weight are detonated by firing a 5-pound explosive charge in good contact with the middle of the case. Bombs of 500 pounds or more are detonated by a 10-pound charge similarly placed. Fuzes should not be positioned on the nose or tail. To ensure detonation, large bombs should be primed separately.

Table B-1. Explosive contents of general-purpose bombs

Bomb	Total weight, lb	Explosive weight, lb
Old series.		
100-lb GP, AN-30A1	120	57
250-lb, GP, AN-M57A1	261	125
500-lb, GP, AN M64A1	549	266
1,000 lb, GP, AN M65A1	1,064	555
2,000 lb, GP, AN M66A2	2,113	1,098
New series:		
750-lb, GP, M117	823	386
3,000-lb, GP, M118	3,049	1,975
Low drag.		
250-lb, GP, MK81 Mod 1	260	100
500-lb, GP, MK82 Mod 1	531	192
1,000-lb, GP, MK83 Mod 3	985	445
2,000-lb, GP, MK84 Mod 1	1,970	945
Low drag, Snakeye I.		
250-lb, GP, MK81 Mod 1, Snakeye I	300	100
500-lb, GP, MK82, Mod 1, Snakeye I	560	192

B-4. Artillery Shells (Nonnuclear)

Artillery shells are used for demolition only where a fragmentation effect is desired. Because of their low explosive content they are seldom used for other demolition purposes. The 105-millimeter howitzer high explosive (HE) shell, which weighs 33 pounds, contains only 5 pounds of explosive; while the 155-millimeter howitzer shell contains only 15 pounds. Shells up to 240 millimeters are detonated by 2 pounds of explosive placed in good contact with the case, just forward of the rotating band. To ensure complete detonation, a charge should be placed on each shell. The M10 universal explosive destructor may be used to detonate projectiles or bombs that have 1.7- or 2-inch diameter threaded fuze wells. The booster cavities of bombs and large projectiles should be filled to the full depth by adding booster cups to the M10 destructor as required.

B-5. Foreign Explosives

a. Uses. Foreign explosives may be used to supplement standard US demolition charges or, in certain cases, used instead of them. Such explosives, however, should be used only by experienced demolition personnel and then only according to instructions and directives issued by theater commanders. The most common types of foreign explosives are listed in TM 9-1300-214.

b. Priming. Most foreign explosive blocks have cap wells large enough to receive US military blasting caps; however, these charges must be test fired with US military blasting caps to ensure positive detonation. In certain instances it may be necessary to initiate the explosives by use of a standard US demolition block primed with a blasting cap.

C-1. Use of Expedient Techniques

These techniques are not presented as a replacement for the standard demolition methods but for use by experienced blasters in special projects. Availability of trained soldiers, time, and material will usually determine their use.

C-2. Shaped Charges

a. **Description.** Shaped charges concentrate the energy of the explosion released on a small area, making a tubular or linear fracture in the target. Their versatility and simplicity make them effective against many targets, especially those made of concrete or those with armor plating. Shaped charges may be improvised (Figure C-1). Because of the many variables, such as explosive density, configuration, and density of the cavity liner, consistent results are impossible to obtain. Thus experiment, or trial and error, is necessary to determine the optimum standoff distances. Plastic explosive is best suited for this type of charge. Dynamite and molten TNT, however, may be used as an expedient.

b. **Preparation.** Almost any kind of container is usable. Bowls, funnels, cone-shaped glasses (champagne glasses with the stem removed), and copper, tin, or zinc may be used as cavity liners; or wine bottles with a cone in the bottom (champagne or cognac bottles) are excellent. If none of these is available, a reduced effect is obtained by cutting a cavity into a plastic explosive block. Optimum shaped charge characteristics are:

(1) Angle of cavity = between 30° and 60° [most high explosive antitank (HEAT) ammunition has a 42° to 45° angle].

(2) Standoff distance = 1 ½ x distance of cone.

(3) Height of explosive in container = 2 x height of cone measured from the base of the cone to the top of the explosive.

(4) Point of detonation – exact top center of charge. Cover cap, if any part of it is exposed or extends above the charge, with a small quantity of C4 explosive.

NOTE: The narrow necks of bottles or the stems of glasses may be cut by wrapping them with a piece of soft, absorbent type of twine or string soaked in gasoline and lighting it. Two bands of adhesive tape, one on each side of the twine or string, will hold it firmly in place. The bottle or stem must be turned continuously with the neck up, to heat the glass uniformly. Also, a narrow band of plastic explosive placed around the neck and burned gives the same result. After the twine or plastic has burned, submerge the neck of the bottle in water and tap it against some object to break it off. Tape the sharp edge of the bottle to prevent cutting hands while tamping the explosive in place

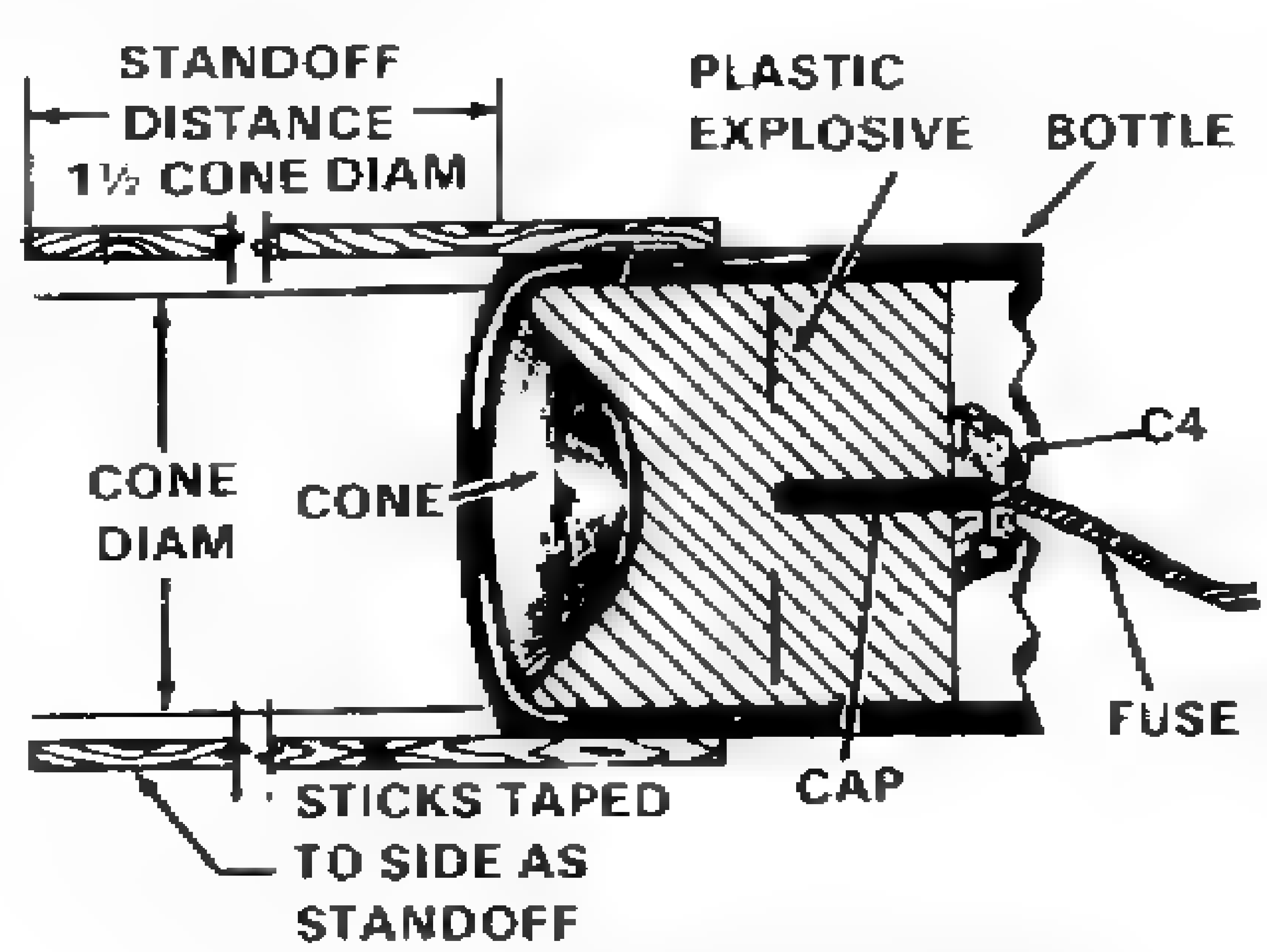


Figure C-1. Improvised shaped charge

C-3. Platter Charge

This device utilizes the Miznay-Shardin effect. It turns a metal plate into a powerful blunt-nosed projectile (Figure C-2). The platter should be steel (preferably round, but square is satisfactory) and should weigh from 2 to 6 pounds.

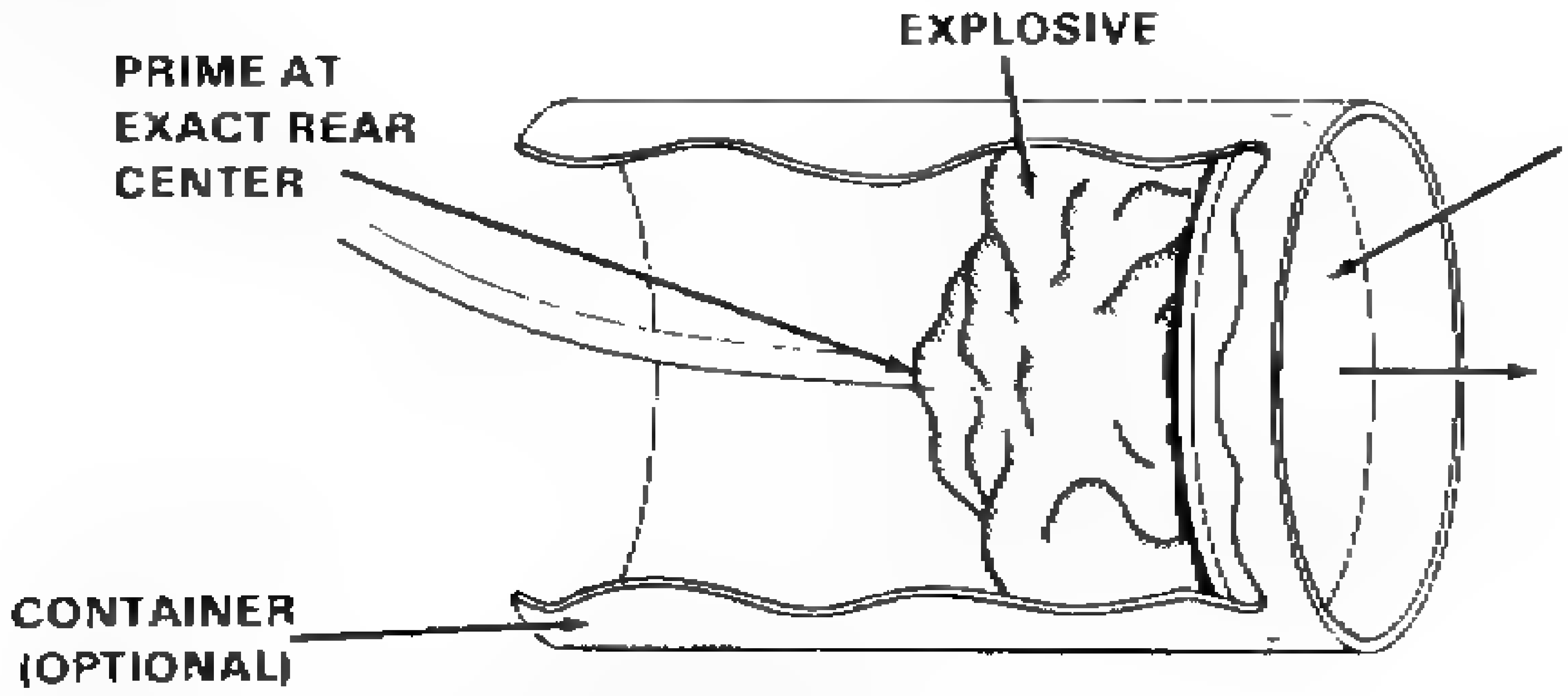


Figure C 2. Platter charge

a. Calculations. Weight of explosive = approximately the weight of the platter.

b. Preparation.

(1) Pack the explosive uniformly behind the platter. A container is not necessary if the explosive can be held firmly against the platter. Tape is acceptable.

(2) Prime the charge from the exact rear center. Cover cap, if any part is exposed, with a small quantity of C4 explosive to ensure detonation.

(3) Aim the charge at the direct center of the target.

c. Effect. The effective range (primarily a problem of aim) is approximately 35 yards for a small target. With practice, a demolitionist may hit a 55-gallon drum, a relatively small target, at 25 yards about 90 percent of the time. A gutted M60 fuze igniter can be used as an expedient aiming device.

C-4. Grape Shot Charge

This charge consists of a container, preferably a No 10 can, projectiles (small pieces of steel), buffer material, an explosive charge, and a blasting cap. These are assembled as shown in Figure C-3.

a. Computation. The weight of the explosive = approximately ¼ x the weight of the projectiles.

b. Preparation.

(1) Assemble the projectiles, a few inches of buffer material (earth, leaves, wood, felt, cloth, cardboard, and so forth), and the explosive charge. This should be C4, packed firmly.

(2) Prime the charge from the exact rear center. Cover the cap, if any part is exposed, with a small quantity of C4 to ensure detonation.

(3) Aim the charge toward the center of the target.

C-5. Dust Initiator

This device consists of an explosive charge (powdered TNT or C3; C4 will not properly mix with the incendiary), an incendiary mix (two parts of aluminum powder or magnesium powder to three parts of ferric oxide), and a suitable finely-divided organic material (dust) or a volatile fuel such as gasoline called a *surround*. The dust initiator is most effective in an enclosed space, like a box car or a warehouse or other relatively windowless structure. At detonation, the surround is distributed throughout the air within the target and ignited by the incendiary material.

a. Computation.

(1) Charge size = 1 pound (½ explosive, ½ incendiary mix).

(2) Cover size = 3 to 5 pounds of each 1,000 cubic feet of target. The 1-pound charge will effectively detonate up to 40 pounds of cover

b. Preparation. Powdered TNT may be obtained by crushing it in a canvas bag. The incendiary mix must be thoroughly dispersed throughout the explosive. A great number of dust materials may be used as cover, among which are coal dust, cocoa, bulk powdered coffee, confectioners sugar, tapioca, wheat flour, cornstarch, hard rubber dust, aluminum powder, magnesium powder, and powdered soap. If gasoline is used, 3 gallons is the maximum, since more will not disperse evenly in the air and thus give poor results.

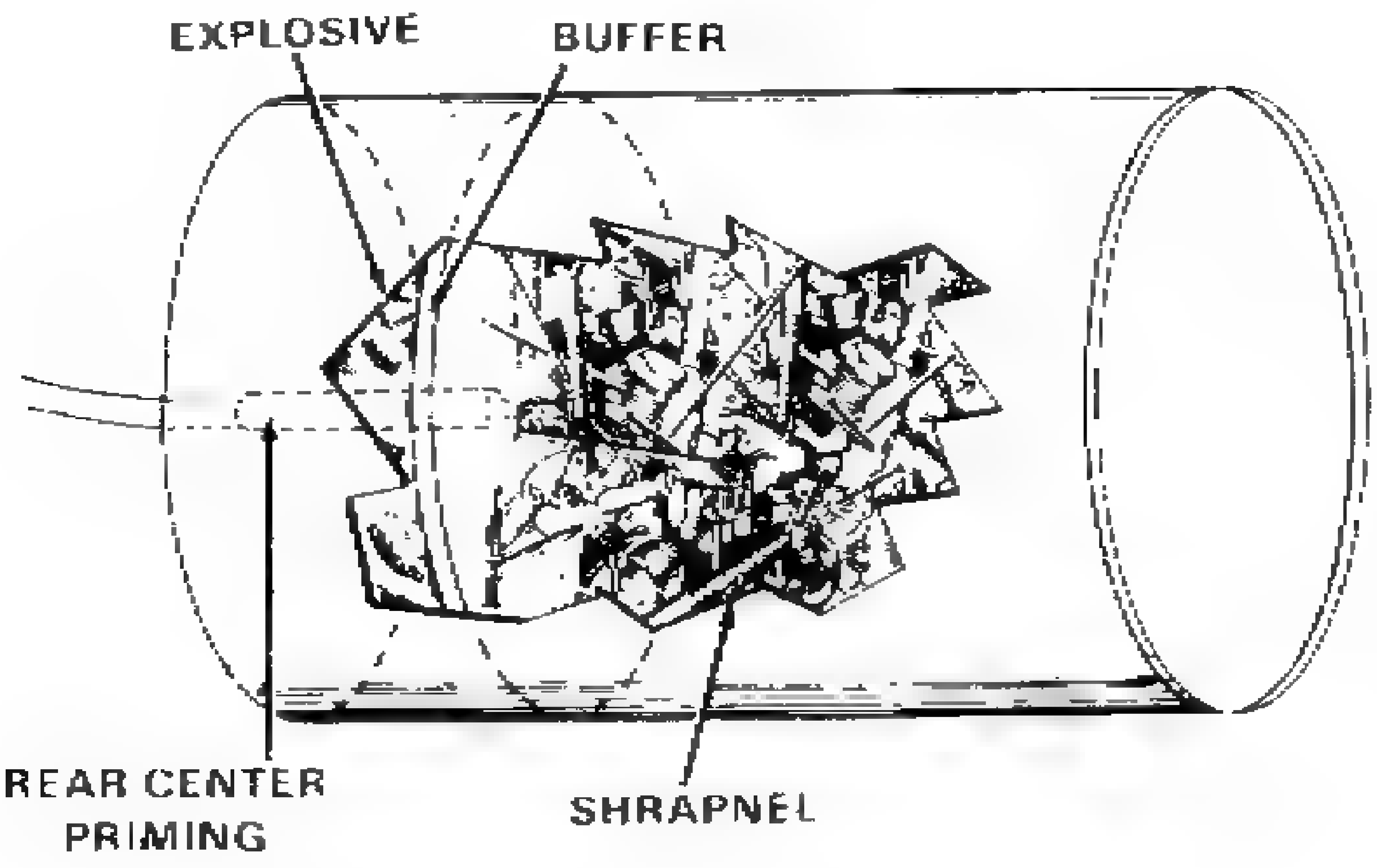


Figure C-3. Grape shot charge

C-6. Improvised Cratering Charge

This charge is a mixture of ammonium nitrate fertilizer containing at least 33 1/3 percent nitrogen and diesel fuel, motor oil, or gasoline at a ratio of 25 pounds of fertilizer to a quart of fuel. The fertilizer must **not** be damp. From this mixture, improvised charges of almost any size or configuration can be made. Proceed as follows:

a. Pour the liquid on the fertilizer.

b. Allow the mixture to soak for an hour.

c. Place about half the charge in the borehole. Then place the primer, a primed 1-pound block of TNT, and add the remainder of the charge. (Never leave the charge in the borehole for a long period, since accumulated moisture reduces its effectiveness.)

d. Detonate the charge.

C-7. Ammonium Nitrate Satchel Charge

Although the cratering charge is excellent, it is suitable only for cratering. A more manageable charge may be used by mixing ammonium nitrate fertilizer with melted wax instead of oil. The primer is set in place before the mixture hardens.

a. Preparation.

(1) Melt ordinary paraffin and stir in ammonium nitrate pellets, making sure that the paraffin is hot while mixing.

(2) Before the mixture hardens, add a half-pound block of TNT or its equivalent as a primer.

(3) Pour the mixture into a container. Shrapnel material may be added to the mixture if desired or attached on the outside of the container to give a shrapnel effect.

b. Use. Because the wax and fertilizer may be molded into almost any size or shape, it may be applied to a great many demolition projects with satisfactory effects.

power requirements for series firing circuit

appendix d

D-1. Series Circuit

In demolition projects, electric blasting caps are connected in series and fired by an electric power source (blasting machine). A series circuit provides a single path for the electrical current which flows from one firing wire through each blasting cap to the next blasting cap and back to the other firing wire. A series circuit should not contain more than 50 blasting caps. The connection of more than 50 caps in a series circuit increases the hazard of breaks in the firing line or cap leads prior to the initiation of some caps.

D-2. Ohm's Law

The amount of voltage necessary to detonate the blasting caps in these circuits is calculated by the use of the basic law of electricity, Ohm's Law. Ohm's Law is as follows:

$E = IR$
E = electric potential, or voltage, expressed in volts.
I = current, expressed in amperes.
R = resistance, expressed in ohms.

D-3. Electric Power Formula

Electrical power is computed by means of the following formula:

$W = I^2R$
W = electrical power, expressed in watts.
I = current, expressed in amperes.
R = resistance, expressed in ohms.

D-4. Electrical Characteristics of Electric Blasting Caps

The current needed to fire military electric blasting caps connected in series should be at least 1.5 amperes regardless of the number of caps. The resistance of a military electric blasting cap is 2 ohms.

D-5. Resistance of a Circuit

Resistance is computed to ensure that the power source is adequate to fire all charges connected to the circuit Both the blasting caps and the wire contained in a circuit contribute to the total resistance of that circuit. This resistance is computed from the individual resistances of the blasting caps and the wire. The resistance of the wire used in a circuit depends upon its size and the length. Table D-1 on page D-2 gives the resistance per 1,000 feet of various sizes of copper wire. The total resistance in a series circuit is the sum of the resistance of the various components of that circuit.

D-6. Calculations for a Series Circuit

Complete calculations for any circuit involve determination of the current (amperes), the voltage (volts), and the power (watts) needed to fire the circuit. Computation of the voltage and of the power requires the determination of the resistance (ohms) in the system.

a. Current requirements. The current required for a series-connected system of special electric blasting caps is 1.5 amperes, regardless of the number of blasting caps in the circuit.

b. Resistance. The resistance of the system is computed as described in paragraph **D-5**.

c. Voltage requirements. Using Ohm's Law, $E=IR$, the voltage needed is computed by multiplying the required current (1.5 amperes) by the resistance of the system.

d. Power requirements. By means of the electrical power formula, $W=I^2 R$, the number of watts of power needed may be found by multiplying the square of the current required ($1.5^2 = 2.25$) by the resistance of the system.

e. Example. Determine the current, voltage, and power required to detonate the blasting caps of a circuit consisting of 20 special electric blasting caps connected in series, and 500 feet of the standard 2-conductor, 18-gage firing wire.

(1) Current required = 1.5 amperes (see **a**)

(2) Resistance.

20 blasting caps = 2.0 x 20 = 40
1,000 feet No 18 wire (Table D-1) = 6.4
Total resistance – 46.4 ohms

NOTE: As 500-foot firing wire consists of 2 strands of No 18 wire each 500 feet long, 1,000 feet of wire is used in the computation for resistance.

Table D-1. Resistance of various sizes of copper wire

1	2	3	4
Size of copper wire			
AWG (B&S) gage no	Diameter, in	Length of wire to weigh 1 lb, ft/lb	Resistance of 1,000 ft of wire, ohms/1,000 ft
2	3/16	5.0	0.2
4	1/4	7.9	.3
6	1/6	12.6	.4
8	1/8	20.0	.6
10	1/10	31.8	1.0
12	1/12	50	1.6
14	1/16	80	2.5
16	1/20	128	4.0
18	1/25	203	4.0
20	1/30	323	10.2

(3) Voltage:

$E = IR$

$E = 1.5 \times 46.4 = 69.6$ volts

(4) Power:

$W = I^2 R$

$E = 1.5^2 \times 46.4 = 2.25 \times 46.4 =$

$E = 1.5^2 \times 46.4 = 2.25 \times 46.4 =$

104.4 watts

D-7. Calculated Voltage Drop

In each of the examples given in (a), the voltage drop (IR) in the blasting circuit was calculated by the use of Ohm's Law. In practice, if the calculated voltage drop exceeds 90 percent of the available voltage, it is recommended that the resistance of the circuit be decreased or the voltage be increased.

D-8. Capacity of Power Sources

a. Determining capacity of power sources. It is possible to determine from the nameplate amperage and voltage rating whether the power source is suitable for firing an electric circuit computed by the methods presented. Frequently, however, the size of a circuit that may be fired with current from a given power source may be determined by consulting Table D-2, which gives the maximum capacities of some power sources. If it is necessary to calculate the capacity of a given generator from the nameplate data, proceed as follows:

(1) Divide 90 percent of the generator voltage (paragraph D-6) by the total amperage of the circuit, 1.5 amps, to determine the maximum resistance in ohms that may be in the circuit.

(2) Subtract the total wire resistance from the maximum allowable circuit resistance to determine the maximum allowable resistance of the caps in the circuit.

Table D-2. Maximum circuit capacities of various power sources

1	2	3	4	5	6	7	8	9	10
		Power Source							
Circuit design	Total number of caps in circuit	10-cap blasting machine	30-cap blasting machine	50-cap blasting machine	1½-kw portable generator, 115-V, 13½-A	3-kw portable generator, 115-V, 26-A	5-kw portable generator, 115-V, 43½-A	3 kw portable generator, 220-V, 13½-A	5-kw portable generator, 220-V, 22½-A
	The circuits below are connected by one 500-foot standard two-conductor firing reel								
10 caps in continuous series	10	X	X	X	X	X	X	X	X
30 caps in continuous series	30		X	X	X	X	X	X	X
50 caps in continuous series	50			X				X	X

(3) To calculate the maximum number of caps, divide the allowable resistance of the caps in the circuit by the resistance of one cap (2.0 ohms)

b. Example. Determine the number of military electric blasting caps in series that may be fired by a 220-volt, 13½-ampere generator using 500 feet of 20-gage connecting wire.

(1) Allowable resistance of circuit =

$$\frac{(0.90)(220)}{(1.5)} = 132 \text{ ohms}$$ (paragraphs D-6 and D-7).

(2) Resistance of firing wire $= \frac{(10.2)(500)}{1{,}000} = 5.1$ ohms

(Table D 1).

(3) Allowable resistance of caps for a series circuit = 132 - 5.1 = 126.9 ohms.

(4) Number of blasting caps allowed in the series circuit $= \frac{126.9}{2.0} = 63.4$ or 63 caps (a3).

c. Use of storage batteries and dry cells. The size of a circuit that may be fired by a battery or dry cell may be determined by following the same procedure as that outlined in (a)(1) through (3).

WARNING | **For safety, disconnect the battery terminal prior to disassembly of the equipment where there is danger from shorting across the battery circuit. In re-assembly, make the battery terminal connection last.**

DA Form 2203-R (Demolition Reconnaissance Report)

appendix e

This appendix provides a blank copy of DA Form 2203-R (Demolition Reconnaissance Report). This form is not available through normal supply channels. It may be reproduced locally on 8½ × 11 inch paper.

CUT HERE

DEMOLITION RECONNAISSANCE REPORT

For use of this Form see FM 5-25. The proponent agency is TRADOC.

SECTION I - GENERAL

1. FILE No.	2. DML RECON RPT No.	3. DATE	4. TIME

	NAME	GRADE	ORGANIZATION
5. RECON ORDERED BY			
6. PARTY LEADER			

7. MAP NAME	SCALE	SHEET #	SERIES #

8. TARGET AND LOCATION	9. TIME OBSERVED	10. COORDINATES

11. GENERAL DESCRIPTION (attach sketches)

12. NATURE OF PROPOSED DEMOLITION (attach sketches)

13. UNUSUAL FEATURES OF SITE

SECTION II - ESTIMATES*

14. EXPLOSIVES REQUIRED		c. Caps		d. Detonating Cord	f. Fuse Lighters
a. Types	b. Quantity	Electric			
		Nonelectric		e. Time Fuse	g. Firing Wire

15. EQUIPMENT AND TRANSPORT REQUIRED

16. PERSONNEL AND TIME REQUIRED FOR:	NCO's	Men	Time
a. PREPARING AND PLACING THE CHARGES			
b. ARMING AND FIRING THE DEMOLITION			

17. TIME, LABOR AND EQUIPMENT REQUIRED FOR BYPASS; SPECIFY LOCATION AND METHOD

* Determine availability of Items 14, 15 and 16 before reconnaissance.

DA FORM 2203 R, AUG 70

CUT HERE

SECTION I. ABBREVIATIONS AND ACRONYMS

A	ampere(s)
ADM	atomic demolition munition
ANFO	explosive mixture of ammonium nitrate and No 2 diesel fuel
AT	antitank
approx	approximately
CEV	combat engineer vehicle
cm	centimeter(s)
Comp	Composition
da	day(s)
DA	Department of the Army
DC	direct current
diam	diameter
F	Fahrenheit
ft	foot/feet
ft/sec	feet per second
gm	gram(s)
GP	general purpose
GTA	graphic training aid
HE	high explosive
HEAT	high explosive antitank
HEP	high explosive plastic
hr	hour(s)
in	inch(es)
lb	pound(s)
kg	kilogram(s)
kw	kilowatt(s)
m	meter(s)
m/sec	meters per second
max	maximum
MD	military dynamite
MICLIC	mine-clearing line charge
min	minimum; minute
mm	millimeter(s)

NA	not applicable
NATO	North Atlantic Treaty Organization
No(s)	number(s)
PETN	pentaerythrite tetranitrate
POL	petroleum, oil, and lubricants
PVC	polyvinyl chloride
QSTAG	quadripartite standardization agreement
RDX	cyclonite
RE	relative effectiveness
RF	radio frequency
sec	second(s)
SOP	standing operating procedures
sq cm	square centimeter(s)
STANAG	standardization agreement
temp	temperature
TNT	trinitrotoluene
US	United States
V	volt(s)
w/	with
W	watts
wt	weight

SECTION II. SYMBOLS

'	feet
"	inches
x	by; times
°	degree(s)
=	equals
+	plus
-	minus
℄	centerline

index

FM 5-25

10 March 1986

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

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ACTIVE ARMY, USAR, and ARNG: To be distributed in accordance with DA Form 12-11A, Requirements for Explosives Demolitions (Qty rqr block no. 22).

Additional copies may be requisitioned from the US Army Adjutant General Publications Center, 2800 Eastern Boulevard, Baltimore, MD 21220.

☆ U. S. GOVERNMENT PRINTING OFFICE : 1989 O - 242-451 (6366)

REQUIRED PUBLICATIONS

Required publications are sources that users must read in order to understand or to comply with this publication.

Army Regulations (AR)

75-1	Malfunctions Involving Ammunition and Explosives
385-63	Policies and Procedures for Firing Ammunition for Training, Target Practice, and Combat

Department of the Army Form (DA Form)

2203-R	Demolition Reconnaissance Report (LRA)

Graphic Training Aid (GTA)

5-10-28	Demolition Card

Technical Manuals (TM)

9-1300-206	Ammunition and Explosives Standards
9-1300-214	Military Explosives
9-1375-202-10	Operator's Manual: Demolition Kit, Projected Charge, M173
9-1375-204-10	Operator's Manual: Demolition Kit, Projected Charge, M157

RELATED PUBLICATIONS

Related publications are sources of additional information. They are not required in order to understand this publication.

Army Regulations (AR)

55-228	Transportation by Water of Explosives and Hazardous Cargo
75-14	Interservice Responsibilities for Explosive Ordnance Disposal
75-15	Responsibilities and Procedures for Explosive Ordnance Disposal

Department of the Army Pamphlets (DA PAM)

27-1	Treaties Governing Land Warfare

Field Manuals (FM)

5-1	Engineer Troop Organizations and Operations
5-31	(C) Booby Traps (U)
5-101	Mobility
5-102	Countermobility
5-103	Survivability
5-106	Employment of Atomic Demolition Munitions (ADM)
9-6	Ammunition Service in the Theater of Operations
9-16	Explosive Ordnance Reconnaissance
17-12-2	Tank Gunnery for M60, M60A1, (AOS) and M48A5 Tanks
17-12-5	Tank Gunnery for M551 Sheridan
17-12-6	Tank Gunnery for Combat Engineer Vehicle, M728

Field Manuals (FM) (continued)

17-12-7	Tank Gunnery Devices
20-32	Mine/Countermine Operations
23-8	M14 and M14A1 Rifles and Rifle Marksmanship
23-9	M16A1 Rifle and Rifle Marksmanship
23-11	90-MM Recoilless Rifle, M67
23-31	40-MM Grenade Launchers, M203 and M79
23-33	66-MM Heat Rocket, M72A1, M72A2 (Light Antitank Weapon)
23-34-1	Improved Tow Vehicle, M901
23-35	Pistols and Revolvers
23-41	Submachineguns, Caliber .45, M3 and M3A1
23-65	Browning Machinegun, Caliber .50 HB, M2
23-67	Machinegun 7.62-MM, M60
23-85	60-MM Mortar, M19
23-90	81-MM Mortar
23-91	Mortar Gunnery
23-92	4.2-Inch Mortar, M30
31-10	Denial Operations and Barriers

Technical Manuals (TM)

5-280	Foreign Mine Warfare Equipment
5-332	Pits and Quarries
9-1375-213-12-1	Operator's and Organizational Maintenance Manual (Including Repair Parts and Special Tool List) for Demolition Materials; Demolition Kit, Cratering: M180 and Demolition Kit, Cratering, Training: M270
9-1375-213-12-3&P	Operator's and Organizational Maintenance Manual (Including Repair Parts and Special Tools List) for Firing Device, Demolition, M122
9-1375-213-34	Direct Support and General Support Maintenance Manual (Including Repair Parts and Special Tools List): Demolition Materials
9-1375-215-14&P	Operator, Unit, Intermediate (DS), Intermediate (GS) Maintenance Manual (Including Repair Parts and Special Tools List) for Demolition Kits, Mine-Clearing Line Charge (MICLIC)
43-0001-38	Army Ammunition Data Sheets for Demolition Materials
750-244-3	Destruction of Equipment to Prevent Enemy Use (Mobility Equipment Command)